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SCIENCE FICTION AND FACT

MARCH 2005

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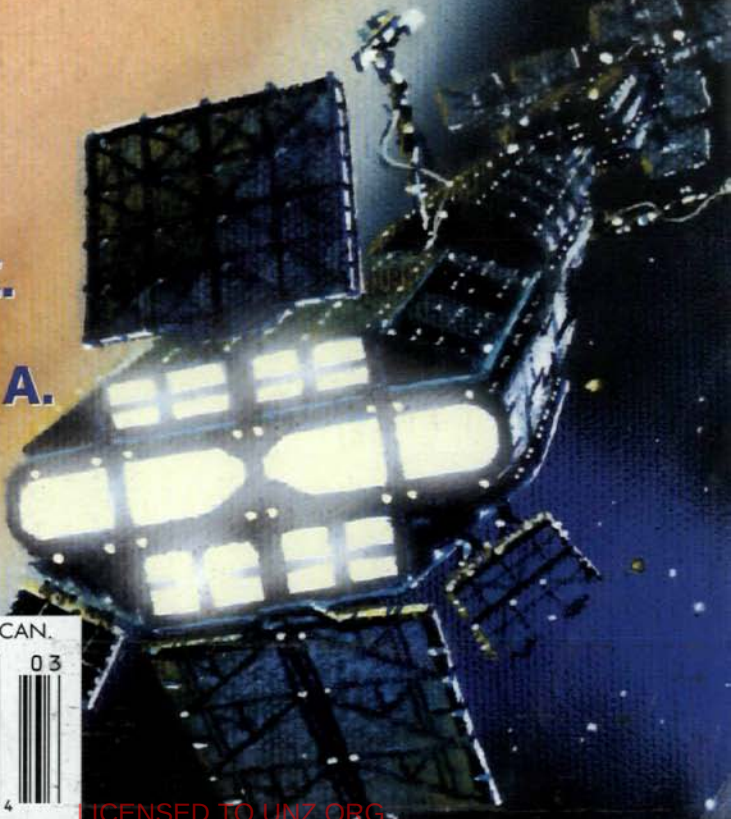

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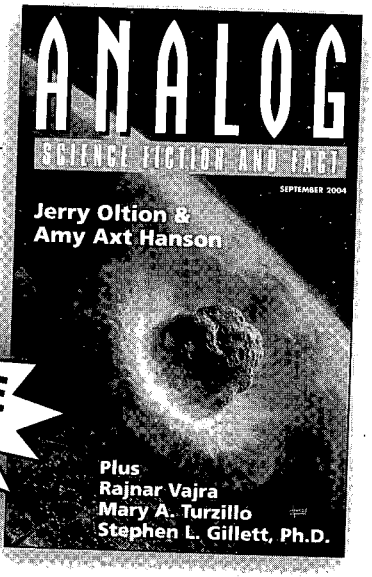

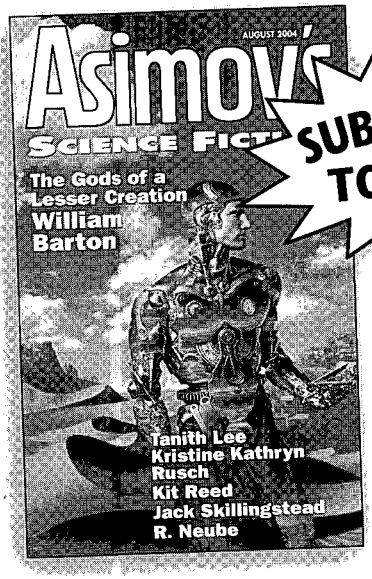

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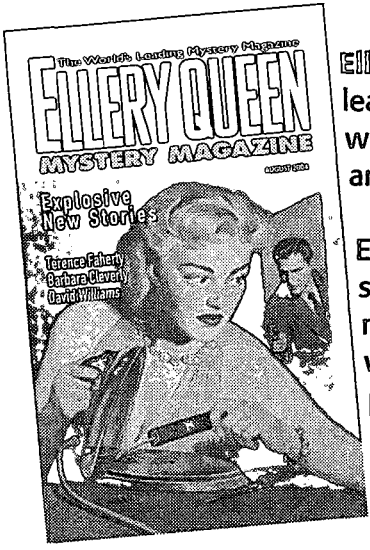

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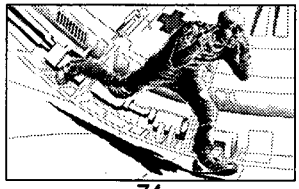
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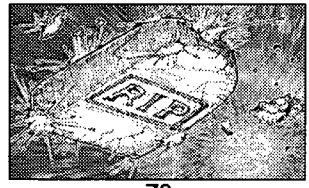

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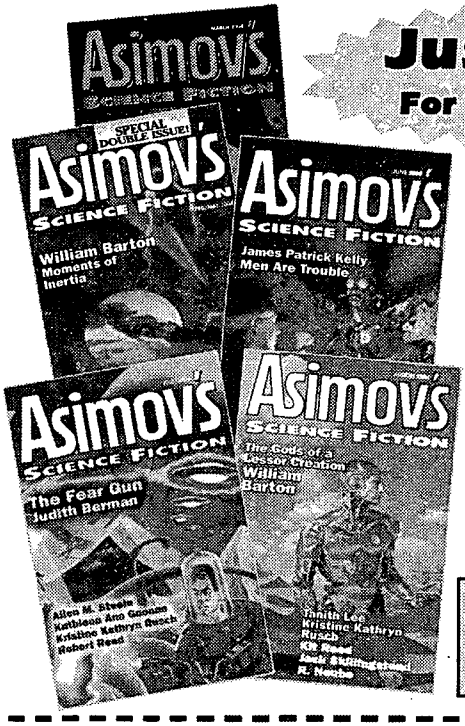

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EDITORIAL Stanley Schmidt

A NOISY SIGNAL

One kind of decision we all have to make throughout our lives is what, if anything, to do about maintaining our own health and fitness. The easiest approach, of course, is to give it no thought, do whatever we want, and let the chips fall where they may. Most of us would probably agree, from our own observation and what we read and hear through various media, that this isn't a very wise course. People who follow it have an annoying tendency to die young from some combination of things like heart disease, strokes, cancer, alcoholism, AIDS, etc.

Almost as easy is to scrupulously follow whatever advice you get from your own doctor, or some other source you regard as authoritative. There's a temptation to believe, though, that that isn't much better. If you're going to try to follow this path, you'd better pick one "authority" and stick to it. If you listen to too many, you'll get so many mutually contradictory recommendations that you'll become hopelessly confused and have no idea *what* you should do.

And if you do pick one and listen to him, her, or it faithfully and to the exclusion of all others, you *still* run a similar risk, because The Authorities keep changing their minds. Cholesterol is bad; some cholesterol is bad, but some is ever-so-good. A diet high in carbohydrates and low in fat and red meat is what everybody needs; a diet high in fat and red meat and low in carbohydrates is what everybody needs. Butter is good as part of a balanced diet; butter is terrible, but margarine is a healthful alternative; margarine is worse than butter. Plenty of sunlight is good for you and a healthy tan is a good sign that you're getting it; sunlight will destroy your skin and possibly you, and there's no such thing as a healthy tan. Lots of bed rest is the best way to recover from Ailment Q; lots of exercise is the best way to recover from Ailment Q. Alcohol is the devil's own curse and should be avoided like the plague; a drink a day offers a wide range of health benefits.

And so on. It's enough (to paraphrase William S. Gilbert) to make an honest patient shudder, and perhaps throw his or her hands up in despair. What *is* a body to do?

What some people do is to make it a point to keep up on all the latest recommendations and follow those religiously. After all, shouldn't the latest recommendations, presumably based on the accumulated total of all knowledge acquired up to now, be more reliable than any of the old ones?

Well, maybe they should, but the disquieting fact is that all the old recommendations were believed just as earnestly as the newest ones, and in some cases they've gone back and forth repeatedly between more or less opposite extremes. What real reason do we have to believe that the latest idea is any better than its predecessors, and not just another giddy fluctuation?

Distressingly little, actually. Yes, the new one is based on new data not available at the time of the other ones. But

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that was true of them, in their time, as well. And there will be new data available in the future that's not available today, almost certainly resulting in new recommendations significantly different from today's. The human body is, after all, an extremely complex system, and no two examples of it are exactly alike.

The practical result is that trying to follow the most up-to-date recommendations mostly results in a life consisting of following fads, with little solid basis for believing that this year's is any better than last year's. Not too long ago I heard someone say earnestly, "Olive oil is *so* good for you!" and I had to suppress the urge to respond, "Well, it is *this* week, but who knows what it will be *next* week?"

And then there are these two inconvenient facts. First, frequently a new recommendation is based on one or two recent studies, casually shrugging off the results of many earlier ones with different findings. But older doesn't necessarily mean inferior; *all* the data need to be accounted for by a truly satisfactory theory. Second, since physiology and medicine are so complicated and variable, and so much interpretation is involved in deciding what a study means, it's often hard to find anything like general agreement on a set of recommendations.

As I write this, for example, we have two highly contradictory fads coexisting in the area of nutrition. (By the time you read this, of course, they may both have been replaced by something else.) Probably a majority of doctors and nutritionists still recommend the kind of food pyramid with a foundation of particular kinds of carbohydrates at the bottom, accounting for most of the food consumed, then smaller amounts of fruits and vegetables, and quite small amounts of meats and such at the pointy top. (Yes, I know these descriptions are oversimplified; I'm not writing a dissertation.) But a good many have become convinced that some version of the Atkins diet, with a strong emphasis on meats and stringent restriction of carbohydrates, is at least as good, at least for short-term weight control. (It hasn't been around long enough to know its long-term effects on all aspects of health.)

There are plenty of people around, both professional and "ordinary citizens," who will swear by one or the other of these approaches to diet as The Only Way To Go. And then there are skeptics like me who suspect both groups are wrong and that there is no Only Way To Go. I think a good case can be made that you're likely to do at least as well by simply ignoring almost all of the fads, striving for moderation in all things (including moderation), and taking specific steps to deal with specific problems if and when you see them developing.

And yet . . .

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Despite the wearying, baffling succession of medical fads, earnestly offering advice that *must* be followed this year but will likely be discarded next year, might there be some longer-range trend that really does warrant serious attention? I think the evidence is strong and clear that there is—but you won't get it from studying today's newspapers or television sound bites. You'll get it from records of historical statistics.

The World Almanac, for instance, has tables of life expectancy at birth showing that the U.S. life expectancy (averaged for both sexes and all ethnicities) has risen from 47.3 years in 1900 to 76.7 in 1998 and quite close to 80 now. Infant mortality dropped from 26.0 deaths per 1000 live births in 1900 to 7.2 in 1998.

Those are huge, dramatic changes. Clearly American medicine as a whole is doing something impressively right, despite the constant presence of contradictory opinions and frequent changes. Doctors and nutritionists may not always agree on the details, and they may change what they say so often that a layman is left wondering why he should believe anything they say. But underneath all that, evidently, is something much quieter but also much bigger and more significant.

What we have here, in the big, diffuse chorus of medical opinion, is a classic example of a meaningful, vitally important signal buried in a lot of noise—much like a staticky radio signal. The fads and bickerings are the noise, the "static." The signal, the part worth listening to, is that body of knowledge that has gradually accumulated and withstood decades of additional testing. The trick is to tell them apart.

And the key to doing that is something much like the "signal averaging" often used to extract signal from noise in radio or sound engineering. Noise tends to be random; average it over several short periods long compared to those of its component frequencies and it cancels out to zero. What's left over is the signal.

What does that mean in practical terms? Recognize that most new recommendations are short-term reactions, and quite likely overreactions, to one batch of recently acquired data. They have an excellent chance of being overturned by another batch of new data in the not too distant future, and so on. One study seldom means much. What

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matters is that core of findings that's supported by study after study, for so many years it can't be ignored. The health effects of smoking, for example, used to be highly controversial, but by now so many separate studies, over so many years, have pointed to the same conclusions that it's hard for anyone to maintain that a cigarette habit is a good way to stack your odds for longevity. Some of the current beliefs about the role of lipids in cardiovascular health are beginning to look as if they have that kind of staying power, but it will still take a while to be sure and there are already indications of significant modifications that may be needed.

The challenge for all of us, of course, is to try to guess what's signal and what is noise. Most of us don't have the luxury of waiting decades to see which opinions hold up before deciding what to eat and how to behave today and tomorrow. Probably the best we can do is to try to get a good grasp of what seems pretty well established so far, and not to respond to every noise peak that comes along. Most of those will turn out not to mean much; but that shouldn't make us forget that down under the noise there *is* a signal with important things to tell us. ■

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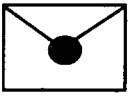

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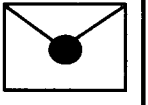

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ACTS OF CONSCIENCE

Shane Tourtellotte

Sticking to principles is widely admired—
but what if the most basic principles
are themselves matters of choice?

"You want us to do *what* to your brain?"

Dr. Lucinda Peale hadn't intended to exclaim, but her visitor's request had been a shock. The woman sitting in her office flinched. "I'm sorry, Ms. Carson," Lucinda said. "I want to be sure I understood you."

Darjeane Carson recovered her poise smoothly. Everything about her was a bit too perfect. She was slender, save for a full bust and backside. Her eyes were a bright green that wasn't quite natural; her hair was a dark blond that shone a little more than hair should. Lucinda was perhaps an inch taller, but there were plenty of short leading men in Hollywood, so Darjeane probably had the edge there, too.

"It's all pretty straightforward," Darjeane said. "I want you to perform one of your brain overlay procedures on me, one that'll give me a political mindset that blends in better in Hollywood. You know," she added, finally looking slightly unsettled, "more . . . progressive."

This time, Lucinda said nothing. For four years, their university research team had performed tightly controlled neural impressions on volunteer convicts and mental patients, overwriting violent, addictive, and deranged behaviors with patterns copied from sections of other brains. For most of that time, Lucinda had had nightmares about the procedure's potential misuses.

She had never expected them to come true exactly this way.

"Why?" she asked, holding down her feelings.

"It's a career move," Darjeane said briskly. "My beliefs have made me a misfit, held me back. You can try to downplay or suppress them, but it's never perfect. People know. I can't lie well enough about them to fool people, either. Maybe that's a strike against me as an actress," she said, shrugging. "It's tough to understand that kind of peer pressure, if you've never experienced it."

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Lucinda had an idea. She had tried to stay politically invisible at the university, a famously activist one. The nature of her work had made that hopeless, but keeping her mouth shut outside of the lab had minimized the damage.

"Ms. Carson, what you're asking isn't practical. Our state oversight has never approved non-correctional use of overlay procedures on humans." That stretched definitions in a few cases, but it was mainly true. "Also, we've never done research on the consolidation of political ideas within the brain. We would have no idea how to do what you want."

"But I've heard that you transfer politics all the time. It's common knowledge."

Peale grimaced, almost shutting her eyes. "It's a common myth. There's no documentary evidence that it happens. If it does, we don't know the mechanisms by which it happens, and it isn't what we intend." *Maybe not all of us*, she admitted to herself.

Darjeane grew intent. "It sounds like you haven't wanted to look at it," she said, stinging Peale. "Now you have a reason." Her ingénue's smile came flashing back. "I'll be over in San Francisco for three weeks or so. Location shooting for a movie. If your team works on it, can you have something ready by the time they're done with me?"

Lucinda was taken off guard. "Ms. Carson, the procedure you suggest may be impossible. In any case, it would take far longer than three weeks to prepare for it. We spent two years performing experimental surgeries on animals before we attempted overlay on a human."

"I assume you've gotten more experienced since then, able to work faster."

"Yes, but—"

"Because I don't have very much time." She opened her crossed arms, presenting herself. "I'm twenty-seven years old, Dr. Peale. That's almost middle-aged in Hollywood these days, at least for women. If I'm going to break out of sixth or eighth billing, to become a star—and last as a star, not just be a one-hit wonder—I have to do it soon.

"I've directed my whole life toward this goal. I've made sacrifices." A hand hovered near her breasts. "I've remade myself, physically, to provide what the business demands. Now . . . I have to remake myself mentally. It's the price I have to pay. I'm ready." The slight slump in her posture disappeared. "And it's my life, isn't it? My choice?"

Lucinda wanted to shout "No!" She wanted to tell her to hold onto her principles, her identity. She wanted to say that some sacrifices were too great. She wanted to say there was no chance this would be approved. She wanted to stop this nightmare cold, before it truly began.

By the time Lucinda had gathered what she wanted to say, Darjeane had rolled her chair closer. "I heard about you, Doctor, while doing my homework about this. People say that you're very good with patients, that you empathize with them. I need that empathy. That's why I came to you. I trust you to take this seriously . . . and to keep it confidential." She leaned in closer. "Hollywood likes controversy, but probably not this kind. Neural impression isn't really popular there."

"I know," Lucinda said. The first paranoid thriller about "mind-wiping" had come out late last year—and had Darjeane had a role in that film?

"I knew you'd understand. That's also why I'd need the through-the-skull stimulation technique, not the open-brain one. That kind of surgery would be tough to hide—not to mention losing this." She flipped at a tress of her hair. "It doesn't grow back fast, and like I said, I don't have all the time in the world."

Lucinda felt paralyzed, all her arguments chained down. She barely managed to say, "Transcranial magnetic stimulation isn't perfected yet. We've only used it a couple of times."

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"I'm not worried. I trust you, and your colleagues." She leaned back in her chair, with another shrug. "I have to, don't I?"

"Come in."

Lucinda entered Dr. Urowsky's office. The neurosurgeon had an image of a brain scan on the holographic platform on his desk, with the hypothalamus and parts of the orbito-frontal cortex highlighted. "Yes, Luci," Urowsky said, putting down his light pen, "what did you want?"

Lucinda decided to match his relaxed informality. "Leonard, I think it would be good to bring a psychologist onto our staff. We need someone who can evaluate our volunteers, weed out people who might be unsuitable to have the overlay. It might help in getting baselines, too."

Urowsky's brow grew deeper furrows. "Really? You've always done very well with that. Kate, too. Why would you change that?"

"I'm not trained in that area. It's something I did because I was available on a short staff early on. Now that the program's larger, maybe it's time for us to trade up."

Urowsky looked at her for a minute. "You wouldn't look so edgy if it were only that. What else is it? Are you thinking of leaving the program?"

"No. I—I—"

"All right. Sit down and let me hear it."

Lucinda's resistance vanished. She related what had transpired during her appointment with Darjeane Carson, including her vague promise to pursue the matter with the research team. She was ashamed of that failure of nerve, of leaving all her principled arguments unsaid. She had slunk away, to torpedo Carson's aim in secret. Maybe it was the habit of lying low—avoiding controversy and confrontation—that had led her to it.

Urowsky put a hand to his chin. "You're right, Lucinda. This is a troubling case, not just morally questionable, but politically hazardous. I take it you hoped that a team psychologist would evaluate and reject Ms. Carson."

Lucinda nodded. "I couldn't bear to do it with her in my office, saying how she depended on me. I wanted that cup to pass from me. It won't. It shouldn't." She stood. "I'll call her now, do what I should have before."

"Wait."

Lucinda stopped. Was Urowsky going to take the burden from her? He was the unspoken team leader through his age and experience, even though he hadn't been with them originally. It was why she had come to him. Maybe she had wished for something like this.

Urowsky surprised her. "Something like this should go before the full team. We have an afternoon meeting scheduled, but I'll see if I can move it up to the morning." He must have seen her surprise. "It concerns us all, Dr. Peale. It probably won't be the last time someone makes such a request, either. We should have an official policy."

"I . . . understand, sir."

"Besides, we're not this woman's only recourse. Other universities are advancing in their studies. If we brush her off, she could go elsewhere. If we give her a united answer, though, she might accept it as definitive. The ethical dilemma would be contained."

Lucinda sighed and nodded. "All right, then." It was the most she could expect, and it would probably work out right. With Pavel in the mix, though, she wasn't nearly as sure of that as she wanted to be.

"I don't see why we shouldn't look at it." Pavel Petrusky cast a wide glance, taking in the whole table. "It's a perfect opportunity to expand our work, to do a little more good—" He looked right at Peale. "—and to put a few fears to rest."

Lucinda began rising to the challenge, but Urowsky stepped in. "Those are fears many people have had from the

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start, Pavel, including in government. The state oversight board is likely to take a dim view of this expansion of our work."

"Not if it's presented to them the right way. I can contact the committee chair, and set up a remote hearing within a week."

"With you to represent us, no doubt," Lucinda said.

"He is our liaison, Luci," Kate Barber said to her side. "It's his department."

Pavel had always had a sixth sense about politics. It made him the logical choice to be their link to the oversight board—and its practical application within the team had made it certain that he would be picked.

"Fine," said Lucinda. One balled hand began tapping the tabletop. "But I will want my objection on the record. To experiment on humans this way, to such an end—"

She froze in mid-sentence. Pavel was laughing. "You cannot be serious. We've experimented on humans with overlay before. Curing my stutter was untested before it was done on me. So was working on the violently insane, including twice on your Muntz fellow."

Lucinda suppressed an eruption. "I resent the suggestion that Joshua Muntz is uniquely *my* case. He's *ours*."

Urowsky was glaring. "Dr. Petrusky, personal comments like that have no—"

"Okay," Pavel said, holding up his hands. "I withdraw that statement—but I don't withdraw my point. We've done plenty of work that couldn't be tested on animals first."

"Fine. Granted." Lucinda had to collect her thoughts: Pavel had her completely rattled. "Let's not dance around the issue. Rewiring someone's political beliefs is destructive, not constructive. It attacks the integrity of the personality on a fundamental level, for no therapeutic reason. That makes it medically unethical."

"Even for someone who wants it, Lucinda?" Pavel asked. "For someone who's volunteering?"

"Consent isn't the issue." She heard her voice rising, and reined it in. "We've had that for all our subjects: Muntz, you, all the way back to Burt Zliceski. But our subjects have had something else in common. They all had something wrong with them."

Pavel sat back, a curious half-smile forming on his bearded face. "Well, maybe your visitor does, too."

There were uncertain murmurs. Nancy LaPierre, a fellow neurosurgeon, spoke up first. "You mean she has some mental ailment making her request this procedure?"

Lucinda shook her head at LaPierre. "That's not what he's saying."

"Look," Pavel said, "she admits that her behavior is maladaptive. She's trying to adjust it, to suit community norms."

Sam Jeong chortled. "Hollywood, normal?" Urowsky stared him down.

"It's a community that's exerting undue pressure on her to conform," Lucinda said.

"Who says it's undue? Her? We don't know her standards, or how extreme her views may be. Her request could spring from a false sense of persecution, of a piece with her maladaption."

Protestations were louder this time, but Lucinda got on top of them. "Now we get to it: conservatism as pathology. A paper from this very university got that notion started, as I recall. It was rubbish then; it's rubbish now."

"Rubbish defined as something too painful for you to believe?" Pavel shot back.

"Enough!" Urowsky quieted the whole room with that word. His glare glanced off Lucinda before falling on Pavel. "Dr. Petrusky, if that is your attitude toward—"

"It's a hypothesis, Doctor. We're supposed to make those."

"You are not supposed to cast aspersions on the mental state of prospective subjects whom you've not even met."

"Hypotheses aren't aspersions—but

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fine, fine. I'll withdraw that statement, too, at least until I have a chance to interview this Jane Doe myself." He looked hard at Lucinda. "Will I be allowed that privilege?"

"Ms. Doe specifically asked for confidentiality," said Lucinda. "Unless we decide to work with her, I'd feel uncomfortable divulging her identity."

"So you keep her all to yourself?" Pavel asked archly.

Lucinda replied with mildness. "She did come to me."

"All right. Can we at least agree to start assembling some data before the oversight board meets? It would just be compiling what other researchers have come up with."

"We haven't agreed that this is going before the committee," Lucinda said.

"Is this meeting going to be one long argument?" LaPierre said pointedly.

Lucinda looked to Urowsky, but his attention was on Pavel. "This would only be compilation, Dr. Petrusky," he said. "With that understanding, I'm inclined to allow it."

"Suits me fine, Dr. Urowsky."

Lucinda deflated. The ensuing vote was an anticlimax. Sam, the most junior member of the team, voted with her. The rest went along with Pavel.

It was probably what he intended all along. Give way on other points, so it would seem more reasonable to grant the one he wanted; make people weary of conflict, so they'd be ready to compromise to avoid it. If she hadn't been so flustered, she might have seen the plan before it was too late.

Maybe getting her flustered had been part of the plan, too.

Lucinda already had plenty of work. The team was deep into studying the neurological roots of pedophilia, intending to make that the next condition they conquered. Lucinda was also pushing examination of profound depression, trying to build on experience from the Muntz case.

Still, she volunteered to shoulder part of the new load. Part of it was the teamwork ethic, doing the work even if she disagreed with it. Mostly, though, she wanted to have some handle on what happened, in case Pavel tried to run away with it.

The information on politics they had on file was thin. Most of it was collected anecdotal reports, from patients who reported having new political opinions after receiving overlays. Nobody there had followed them up. They had dismissed the stories, not believing them, or not wanting to believe.

Lucinda was surprised at the numbers: a little over half their patients had made claims. The trouble was, rumors about excess transfers had been rife for years. Most of these subjects could have heard them, and imagined or invented similar symptoms. Even "her" Muntz fellow.

Other university research teams had better data. Her team's practical work meant less time for the theoretical, the in-depth study of neural structure and function. They borrowed from these other teams all the time. The requests Lucinda sent to them for the most recent data on this particular new subject wouldn't seem too far out of place.

She expected to receive uploaded files and e-mail notes. Instead, her first response came by video call from UCLA, from someone she hadn't thought about in some time.

Frances Roselli hadn't aged well in the four years since she left the Berkeley team. Her black hair had gone almost totally gray, and her face had deep lines. They made her seem fierce as she looked out of Lucinda's monitor.

"I worried from the first that things would slide down this slope," she said. "I had hoped you wouldn't be pushing them down."

Lucinda absorbed the shot stoically. "This is the team, Frances, not me."

"You don't have to go along with the team, Lucinda. I showed you that." She

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didn't give Lucinda time to muster a reply. "Was *she* the one who started this?"

Lucinda started. "Who?"

"A prospective volunteer. I won't name names, but she's young, ambitious, and a little more bright and shiny than nature would allow."

"I . . . I couldn't—"

Frances saw through Lucinda. "Thought so. She came to me a while back, asking whether we could make political alterations to her here, or at least refer her to people who could. I turned her away cold. It seems you didn't."

Lucinda flushed. "I'm sorry I couldn't be as brusque as you," she said, more harshly than she felt.

Frances's frown softened. "Maybe you are. You looked conflicted back in '19—even if you didn't admit it—when you brought those legislators into the program."

"You know what my intentions were, Frances." The Assembly had been ready to stifle their program in its infancy. Many legislators thought neural impressions the equivalent of brainwashing. When, in desperation, Lucinda offered them the chance to provide their own brain pattern templates to the pool, though, enough changed their minds. She was using their misapprehensions in her favor, even if she worried from the start how false their impressions were.

Frances shook her head. "It was a ghastly risk to take. Even if you were right, I knew what would come of letting people think that brainwashing by inches was acceptable. So I left Berkeley." She sighed. "But I didn't leave the problem behind."

She looked at her hand, hovering over her keyboard. "I have a group of files I'm supposed to send you. If it were just me, I wouldn't. It's not my decision, though, and if *I* don't . . ."

"I know what that's like."

Frances gave her a burning look, and whispered something sulfurous under her breath. Her finger hit a key, and the picture went choppy for a moment as the files came through the line.

"I wish we'd never gathered that data. I wish I hadn't . . . well, you've got what you wanted. I have to go. I have . . . thinking to do."

"Goodbye," Lucinda said softly.

Frances stopped short of cutting the connection. "Oh, and next time you talk to our mutual acquaintance, ask her why she isn't looking to get an impression of better acting chops." The picture winked out.

"My acting skills are fine, Dr. Peale. I have scrapbooks full of good reviews, if you want to see them."

Darjeane had taken a couple of days to return Lucinda's call, catching the doctor at lunch with just an audio-only phone. Lucinda had called to inform her that matters were proceeding to the ethics board, but she had to add that nagging question.

"I'm not trying to be insulting. I've just never followed your career closely before."

"I'm good," Darjeane said. "I could've gotten an Oscar nomination last year for *Three Pairs*. The studio had to campaign for Miss Jones instead—in her contract—so neither of us got Best Supporting. That's what happens when you've got no clout, when you're not a star. Anyway, what does this have to do with my . . . request?"

"Just that if you want critical success, there are less extreme methods of getting it. You could try Broadway plays, television, Net series—"

"That's not what I want. I don't want to be in a box, or on a stage. I want that huge screen. I want people watching that screen because of me. I—" Her tone changed. If the phone had a screen, Lucinda knew Darjeane would be flashing her best ingratiating smile. "You must understand ambition, dedication, to have built up a career as a scientist."

"Dedication, yes," Lucinda said. She had never, though, been so intensely de-

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voted to anything. Not to study, not to work, not even to her husband. Of course, Keith had left her life twelve long years ago. How much worse could that have been, if she had been obsessed over him?

"Good. It's probably your hard-earned professionalism making you test me. I understand. It means you'll be that much more deeply convinced, and more persuasive to others."

Lucinda sighed. "Ms. Carson, honestly, you aren't persuading me."

"I've noticed," Darjeane said, "but you're being pleasant about it. I'd thought about taking this to your Dr. Petrusky—the one who gets on the news—but he always felt too hard-edged for me."

Lucinda accepted the flattery, calculated as it was. She didn't want Darjeane to know how much more agreeable to her cause she would find Pavel.

Lucinda spent a half-day at the lab on Saturday, then returned home. She changed into sweats, and covered her short hair with a white cap. It was the proper outfit for the company she expected.

She answered the knock at the front door. Joshua Muntz stood outside, looking less like thirty-six than like a gawky teen in a T-shirt, scuffed jeans, and a faded A's cap. He held two brushes and a roller, and had a dropcloth under his arm. "Hi. Didn't know if you had enough supplies, so . . ."

"We'll be fine. Come on in, Josh."

Josh took a few steps inside, then froze. A Rottweiler was loping up toward him, giving him a curious look. "Uh . . ."

"Don't worry. Ben's completely harmless. You can put your stuff in there." She pointed to the living room, already partly emptied and covered. "We'll do this today, the kitchen and dining room next weekend, and upstairs afterward."

Hiring Josh was part help for him, part expiation for her. The overlay that had cured his violent schizophrenia also left him profoundly depressed, from guilt over the attacks his sick self had committed. A second overlay, the new non-surgical variety, had alleviated that, but Lucinda still felt she owed him. Especially since there were other problems they hadn't touched.

She fetched the paint cans in the kitchen. When she came back, Josh was kneeling next to Ben, being sniffed. Ben apparently approved. When Josh patted the dog's coat, Ben came closer, rubbing himself against Josh's other arm.

"Hey, you like that, don't you?" He rubbed harder. Ben's eyes got big, as if he'd known and trusted Josh for years. Josh grinned.

Lucinda felt a pang. She was pretty sure she had never seen Josh smile before.

Josh's pats migrated to Ben's head. Ben suddenly whined and flinched away. "Sorry, pal. I just—" He felt gently along the side of Ben's head, and shuddered. "Doc," he said, raising a hand to his cap, "he's got . . . my scars."

Lucinda nodded. "He was one of our test animals, five years ago. Illegally bred for attacking. We cured him, and when we were done, I adopted him."

Josh stood and took a step back, looking at Ben. His silence went on too long for Lucinda. "And he's got to stay in the backyard while we're working. Sorry, boy. C'mon," she said, beckoning. Ben trotted after her, looking back once at Josh.

Soon the living room had their attentions. Once their work fell into a rhythm, they exchanged small talk. Josh complained about Oakland's baseball woes, and Lucinda managed to keep up. He was less lively talking about his search for vocational schools, mentioning several possibilities without much enthusiasm.

He was even less voluble talking about his parents. They fought almost constantly now. The emotional stability they were supposed to provide during

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his integration into society was just the opposite. Talking about it was the only thing that made his work pace slacken.

"I'm sorry I brought them up," Lucinda said.

"No, it's okay," said Josh, as he soaked his roller for another pass. "I know you're checking on how I'm doing. That's probably why I'm here: to see if I'm functional."

"No, Josh, I—"

"Don't worry, I don't resent it. Besides, it's probably lighter conversation than me asking about your work."

That was an understatement. It got her thinking, for the span of half a wall. She finally decided to chance it, since he was already expecting such things.

"Do . . . stray thoughts still bother you, Josh?"

Josh stopped with one foot on the stepladder. "Sometimes. I've gotta work to get on top of them sometimes, when I get sudden phobias about genemod foods, or certain faces on TV. No, actually, it's the voices. They can really set me off, even if I want to listen to what they're saying."

"Are the intrusions bad?"

"Not always." He grimaced, and turned back to his painting. "But yeah, kinda bad."

Lucinda girded herself. "Bad enough that you'd go through neural impression again to get rid of them?"

"Sure. Overlays were never that bad, especially the last one. It'd be lots easier to—" He turned around abruptly. "You're saying you can do that now?"

Lucinda shook her head. "No, we can't."

"Then you wouldn't have been asking about it. Doc, if you can—"

"No!" she said, freezing him before he could clamber down. "Josh, I swear, we don't have that kind of procedure. We don't even know how we'd try to go about doing it. I was just . . . curious about how you were coping."

Her avowal of concern barely lifted Josh's forlorn look. "I'm sorry, Josh. If we ever do develop that ability, I promise I'll tell you."

Josh nodded weakly. He went back to painting, noting with dull interest the paint dribbles on his arm from his inattention the moment before.

Lucinda turned back to her own work, speaking just loudly enough to hear herself. "I will."

Pavel swiveled in his chair as Lucinda entered his office. "The oversight board convenes tomorrow morning at ten. When will you have the information ready for me to see?"

"It's ready now," Lucinda said. "I can upload all the data to you when I'm back in my office. Will they really need all the research data for that meeting?"

"I'll need it all. I have to figure out the finer points of my presentation: what we know, what's left to learn, what we can do with our knowledge. The board appreciates having things spelled out clearly."

The oversight committee had received their mandate some months before, after the legislature grew tired of the controversy of overlays, and of the frequency of requests to expand their scope. Maybe they'd gotten tired of Pavel too, Lucinda thought. He had thrown himself into the role as spokesman after his stuttering cure. He was effective—and pretty insistent sometimes.

Lucinda took a breath. "Would it make a better impression if we had two volunteers?"

"Yes, but—" He turned a questioning look on her.

"Joshua Muntz," she said.

His look turned sour. "You told him? I question the ethics of soliciting a volunteer, Luci."

"I didn't tell him—and we started this project by soliciting prisoner volunteers, so don't give me that." Her sharp response made him twitch. "Joshua told me himself, he'd like to have restored what we changed. The part that wasn't

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unwell, I mean."

"That part wasn't changed," Pavel said, turning back to his computer. "The evidence, quote unquote, is all anecdotal."

He started tearing into his work, fingers flying across his keyboard. Before his operation, Pavel's work had been methodical, when it wasn't outright slow. His office back then had also been a bit of a mess, not spotless and organized as it was today. Didn't he have to notice, Lucinda wondered.

"I've told myself that," Lucinda said. "I told Josh, too. But I was wrong. I've seen too many of the anecdotes we've collected not to see the forest those trees make up, Pavel. We are doing something to our subjects that we don't intend. We have an obligation to understand what that is, to stop it. And for people like Josh, we have an obligation to undo it if we can, to make him whole, the way we worked on the depression we reinforced when treating his schizophrenia."

"We're not obliged, Lucinda. For one, Mr. Muntz may not be competent to judge his own case. And don't get defensive," he said before Lucinda could react. "You know what he's been through. Besides, giving him two overlays inside a year was unprecedented enough. I wouldn't want to chance three."

"You think you're going to have a practical procedure that soon?" Lucinda said. "I don't see it."

Pavel cocked an eyebrow. "You mean you don't want it."

"It is possible for both to be true." Then again, if it were only for Josh's sake . . .

"We are going to pursue this, Luci," Pavel said while typing away. "I hope you'll be with us."

"The way you say it, it sounds like I'm not part of 'us' any more."

Pavel gave her a glance. "Are you?"

She reddened. "Don't worry. I'll do my work . . . but you might want to turn that terrific political brain of yours to the future. This is dangerous ground we're on, with immense potential for abuses. It needs serious ethical oversight. Something more formal in our team, for one. Maybe something better than the state board, for another."

"You want to hand it back to the legislature and the governor to play with?"

"For something this powerful, it ought to be in their hands. At least they're accountable to the voters." She edged closer, trying to get into Pavel's angle of vision. "But it doesn't stop in California. The study program at Johns Hopkins is starting to branch out. Penn State's gearing up, too, even with their lie-detecting scans mired in the courts. Congress has to start looking at this."

Pavel finally looked up. "And what will they do about Europe? Or Asia, or the rest of the world? National borders won't impede this technology any more than state borders will. Are you ready to take on the world, Lucinda?"

She took a step back. "Not yet. Not by myself. That's why it's so crucial that we start on the right foot, set a proper example. We need to remember that everything we discover will make it easier for the unscrupulous to exploit this technology later."

Pavel stopped typing. "Are you saying suppress our knowledge?" he hissed.

"It's not suppression if we haven't discovered it yet."

"That's sophistry. Repressing the search for knowledge would be just as bad."

Lucinda wasn't sure of that, but she was sure she wouldn't persuade Pavel otherwise. "Then you'd better have a firm grip on what's being done with that knowledge."

Pavel smirked at her. "Having an Oppenheimer moment, Luci? 'I am become Death, the destroyer of worlds?'" He chuckled. "For all his worries, nobody's used a nuclear weapon in over seventy-five years."

"It's one thing to use an invention to kill a hundred thousand people," Lucin-

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da said. "If you're altering their minds, one by one, the moral threshold is a lot lower."

"Granted," Pavel said. "But you know what Oppenheimer's solution was, don't you? Keep the scientists in control. Well, we are still in control, and I'm sure not going to give it up easily."

Lucinda said nothing, withdrawing quietly as Pavel beavered away at his work. She was not at all reassured by his last words.

There was no surprise from the ethics board. Pavel emerged with official permission to study how the human brain absorbed and organized political ideas and beliefs. The new call for volunteers began with posted flyers that evening, and in the leading student paper the next morning.

Kate and Lucinda began screening applicants in private consultations. After signing preliminary confidentiality agreements, the volunteers learned what information would be gathered from them, and the probable timeframe. Pavel wanted it started almost immediately, compressing their current work or postponing it.

Many applicants changed their minds. Some just slunk out of the office, muttering excuses or saying nothing. Some left in anger or worse, lashing Lucinda with epithets like "fascist," "Nazi," or, in the loudest and bitterest cases, "Republican." Somehow worse were the few who just looked at her reproachfully as they left, as if she had betrayed them.

Those who stayed in got a sheet of general questions on politics, and a pocket-comp on which to record their answers. Their answers to the survey would provide rough baselines for the scans to come.

Interviews wrapped up the next day. Lucinda took a few hours to compile her data and Kate's, and reported to a full staff meeting late that afternoon.

"We had a higher than usual rejection rate this time, mostly self-selected. The remaining volunteers will still easily be enough to proceed. Through baseline data, and personal observation during the interviews, some interesting facts are already emerging."

Attention picked up around the table. Urowsky in particular eyed her, but said nothing.

"There's a strong tendency within the remaining pool toward political awareness and activism. I suspect many of our departures were by the politically apathetic, or people reluctant to insert themselves into political controversy."

"You're right, Luci," Pavel said. "This is personal observation. Anecdotal, no more."

"Granted," Lucinda said, "but it tallies with other anecdotal evidence from previous calls for volunteers. Those pools appeared to tilt toward activism versus apathy, especially in later drafts, as certain rumors about the effects of neural impression spread." Pavel didn't blink. "There was also always a substantial leftward tilt to the volunteers, to be expected on this campus. My impression is that both those trends were strengthened in this group."

"No." Pavel shook his head. "This is sheer supposition. We have no political data on previous groups. No evidence at all."

"That's not entirely true," Kate Barber said. "Some of our current volunteers are repeats, over ten percent. Whatever opinions they hold, they're already in the template files."

"And depending on what we learn from this study," Lucinda added, "we may be able to get glimpses of the ideas and philosophies of past volunteers from their templates."

"Are we allowed to do that?" Sam Jeong asked.

"As long as confidentiality remains in place, yes," Urowsky said.

"I'd insist on it," said Lucinda. "It would give us a chance to put hard data behind our anecdotal evidence." Pavel might have flinched that time. "Now,

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while our volunteer pool is adequate, I hope we could supplement it, with an eye to balancing it in terms of political interest and ideology. I note that we placed an ad in the lead campus paper, but not the conservative alternative."

"They publish weekly," Pavel noted tartly, "in both senses."

Either Kate or Dr. LaPierre chuckled at the jibe: Lucinda didn't look to see whom. "An ad there, along with notices in a couple other targeted places, would diversify the pool."

"Irrelevant," Pavel said. "We don't need a broad pool. We're studying mechanisms for now, not ideologies or pathologies . . . or intersections thereof."

"Are we back to that again?" Sam said, sparing Lucinda from having to challenge Pavel.

"We are not," Urowsky said, quelling Pavel with a glance. "I'm inclined to expand our appeals, Dr. Peale, within reason. What do you have in mind?"

She named the paper, a couple of dormitories, and a website passed over by the initial call. The team agreed without dissent, though Pavel abstained.

His handling of politics wasn't perfect after all, Lucinda saw, not when he got bound up in it personally. He didn't always get his way. That nudged her to act. "I have one last way to expand the pool slightly, with a specific volunteer: myself."

Heads snapped up. "Now *you're* injecting your politics into this," Kate said.

"No. I'm injecting my ethics. You all know I've resisted this turn in our work, and why. I'll continue to participate, but I think this added involvement will act as a safeguard, a tripwire. I'm hoping you will be less inclined to be morally . . . adventurous when a colleague is involved." She cocked her head. "And if my template makes the pool more diverse and moderate, all the better."

Urowsky and LaPierre held identical poses of uneasy thought. "It's an unusual request," LaPierre said. "Perhaps—"

"I'll back her," Pavel said, to Lucinda's surprise. "In fact, I'll volunteer, too."

"Now, Pavel—" Urowsky began.

"I'll be an even better subject: you already have my template on file." He looked coolly at Lucinda. "And I'll add balance."

Lucinda met his gaze calmly. It wasn't what she had expected, but she could live with it.

The team had previous surveys to finish before starting their new one. Lucinda intended to give the surveys proper, unrushed attention—even though she didn't want to spend a minute in the presence of the subjects.

Hers was a common reaction. Pedophiles were loathed even among the dregs of prison populations. It explained the high volunteer rate among them for overlay research, higher than any group before. They sought to escape their lot, permanently by being cured, or just for a few hours away from their tormentors in prison.

Kate and Sam were as distressed around them as Lucinda. They all took turns in the examination room, talking the prisoners through their crimes so the magnetoencephalograph could record their brain activities. Lucinda had mostly mastered her sensations of dread around violent offenders, but these men, these acts, gave her moments of panic she hadn't felt in years.

Her times in the observation booth, concentrating on analysis, were much easier. There, they almost seemed like normal violent prisoners. Most had the familiar low activity in the frontal lobe, especially in the orbito-frontal cortex, the seat of inhibitions.

That wasn't quite true, though. That area fired rather normally during indirect questions. When recalling specific instances of abuse—methods of luring or procuring, the actual abuses—it damped down. There were also odd activity patterns in the medial preoptic area of the hypothalamus. Were those patterns the shape of pedophilia?

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Some traits, like the small hippocampus and the active amygdala, became familiar. She had seen those before: they were signs of trauma in early life. Many of these men had been sexually abused themselves, the patterns imprinted early, then reinforced when they repeated the past as the perpetrators.

Lucinda saw the pattern in one man whose dossier made no mention of abuse suffered. She attached a note to the file, saying he probably had been abused but never admitted it.

These sessions of observation settled her. She needed to see the madness broken down, made comprehensible. It might make being around them tolerable in time.

That thought disturbed her all over again.

She managed to get through the roster with no serious panic attacks. She returned to the scanning room, as the guard re-shackled his prisoner and escorted him out. Lucinda followed them, at a distance. She had one more patient today, but not part of that group.

She entered the spartan waiting room just as the prisoner was shuffling out. Josh Muntz stood from his chair, watching over his shoulder as the door closed. He yielded to a shudder. "I'm sorry I came early," he told Lucinda. "I was institutionalized with some nasty characters, but he—"

"I know, Josh." She led him into the scanning room. "Will you be able to make it at two tomorrow?" she asked, hoping to give him a distraction.

"Count on it. I'll even bring a little toy for Ben, to make up for his exile."

As she adjusted the MEG, Pavel came into the room. He looked Josh up and down with a hard eye. "It's his monthly check," Lucinda said. "I didn't think we should reschedule him."

"I know," Pavel said, flashing the screen of his pocket-comp. "Kate had to leave for her doctor's exam. I'll be working with Sam in the booth. You can sit right down, Mr. Muntz."

Pavel drew her over for a moment's consultation on a trivial matter. She noticed Josh stayed standing, giving Pavel a long, dark look. Once she was finished, she went to settle Josh into his chair, so he could go under the headset of the MEG.

"Figures," Josh muttered. "I hoped he wouldn't be here, putting his spin on my scans."

Pavel, not quite to the door, turned. "What was that?"

"Nothing, Pavel," Lucinda said quickly.

"It's not nothing." Josh stood up and looked right across the room. "I know you don't believe my first overlay gave me more than I bargained for. Maybe you should let someone more open-minded do the monitoring."

"Josh—" Lucinda began, but Pavel was faster.

"There is nothing wrong with my open-mindedness, Mr. Muntz," said Pavel, striding over. "I believe what the evidence shows."

"If you know how to read it." He stepped around Lucinda, who was trying to interpose herself between the men. "Maybe you don't like the implication that the great re-molder of brains might not be perfect. I'll tell you, I like it a lot less."

Pavel scowled. "You, of anyone, are in no position to judge my competence."

"Enough!" Lucinda finally got between them. "Not another word, Josh. Get into the chair. I'll be right back."

She steered Pavel toward the door to the booth, saying nothing until she had some distance from Josh. "I will not have you abusing my patients," she hissed. "Any more, and I will report you to Dr. Urowsky."

Pavel gave her an incredulous look. "*My* abuse? How protective we are." His face fell into a sneer. "Cut the strings, Luci. You already have one pet."

He was through the door in an instant, leaving Lucinda dazed in his wake. She went back to tend to Josh, wonder-

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ing how she'd calm him enough to get a decent baseline scan of his brain. Her own frame of mind, she managed to ignore.

Lucinda spent a long night organizing the data, and got an early start on her Saturday half-day. She wanted things in order before she could relax—if an afternoon breathing paint fumes was relaxation.

Their study of pedophiles was going to bear fruit. Common patterns of brain activity were coming into focus. The surgeons would soon have a treatment program to impress new potentiations onto selected networks of their neurons, to overwrite destructive patterns with healthy ones. They could be set right.

But the team needed to go further. The victims of molestation had to be treated, not merely out of mercy, but to interrupt the generational cycles of abuse. It would be tough to convince the ethics board, or the Legislature, to allow them to work on adolescents, on children. Worse, though, would be waiting to treat them until they had to come in chains.

Pavel surely would back the proposal all the way. It fit his mindset that favored therapy absolutely, and scorned any hint of the punitive in what they did. She wasn't perfectly comfortable having him lead the way, but her qualms were milder than usual.

An icon flashed on her screen. Well, think of the devil. Pavel usually liked to talk to her in person, but after yesterday, she was fine with the distance of a call right now.

He popped onto the screen. The room behind him wasn't his office: he must be calling from home. "Morning," he said. "I guessed I'd find you there."

"Not much guesswork needed," Lucinda said with a nod. "I want to run an idea about—"

"Actually, I wanted to k-keep this short." Lucinda noticed the stutter that almost never returned, and his hesitation. "I . . . have been thinking about your proposals last week."

"Umm . . . which ones?"

"About having our own ethics committee, for one. I'll back you on that with the rest of the team. I'll also support bringing aboard a psychologist, if you really want one."

"I said I did," Lucinda said carefully. "I *still* do."

"Okay. Just be careful. With the new transcranial overlay method, actual bone-cutting neurosurgeons like me could be expendable pretty soon. I'm thinking that, with a psychologist on the team, your good manner with patients might not be needed so much, either. Fair warning," he said, half-grinning.

"I'll take my chances, Pavel." Speaking of which, she decided to take another. She didn't know whether Dr. Dreher would come over from Oak Shade, but she would try to get her. The fact that she had worked with Josh Muntz might raise Pavel's hackles, but she'd chance it. "I have someone in mind for the position—"

"Good. I'm sure it'll go smoothly. I'll let you get back to work now. Bye."

Just like that, he was gone. Lucinda wondered at his change of mood from yesterday. Was this another of his calculations, politics on the smallest scale?

She decided not to question it too closely. She'd take what he gave, and be glad.

The new set of MEG scans began on Monday, but the trouble began before the first volunteer arrived.

Lucinda saw the demonstration outside the lab building, and promptly turned her car toward a different garage. She went into the building next door, the one with a connecting tunnel in the sub-basement. Either none of the protestors had thought of that, or they had been cleared away.

So it was out. The only question was, who told?

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The daily campus paper in the mailbox outside her office gave her the answer. The "exposé" of their new study was on the front page: it almost *was* the front page. The writers didn't reveal who gave them the story, indeed reveling in refusing to name their informants.

Lucinda folded up the paper, and checked her messages. The e-mail filter had screened out several notes, which she made herself inspect. All were abusive, but none actually threatening, so she deleted them. She did the same with the hate calls on her voice mail.

The surveys went on nearly as usual. Two subjects called to postpone their sessions, and one cancelled outright. The other sessions went on as though nothing had happened. The scientists didn't raise the matter in the volunteers' presence, and barely spoke of it among themselves, at least not in Lucinda's presence.

By the time Lucinda left her office that evening, she thought the furor had burned itself out, a quick fizzle for this campus. Even the freshly printed polemical flyer on her windshield didn't bother her, until she spied "This means YOU, Peale!" scrawled at the bottom. She stuffed it into her bag, thinking vaguely about preserving evidence.

She was out of the garage, almost home free, when something cracked near her head. She turned to see the remnants of egg and something brown smearing down the window. The next instant, she heard and felt something thud against the back of the car. She looked back, but couldn't see anybody. She began to slow, then hit the gas, and got away before anything more happened.

"If it wasn't one of us," Dr. Urowsky said, "then it was one of our applicants, or more than one. They're probably people who left without joining, but we can't be certain."

Urowsky looked dark under his eyes, as though he had slept badly. LaPierre's shoulders hung lower than usual. The rest of the team looked little worse, but the way some glanced at Lucinda, she assumed she was showing some effects.

"They signed confidentiality agreements," Jeong said. "That means they breached them, and we can take action."

"Against whom?" Barber said. "We have no names."

"So we go to the editors of that paper, explain that our rights have been violated, and ask them to tell us who—" Jeong was stopped short by Pavel's laughter. "I don't see the joke," Jeong flared. "They'd roast us if we broke that agreement. Why protect someone else who broke it?"

Pavel kept laughing. Lucinda gave Jeong a sad shake of her head. He seethed, but said no more.

"So we may have moles in our study group," LaPierre said, "who could keep committing acts of sabotage like this. Do we cancel the study?"

Lucinda would almost have been glad. It would mean no more worrying whether someone would find her unlisted home number, or street address. It also meant giving a victory to whoever pelted her car and made her sneak into her own lab. Never mind that she might sympathize with their cause, for once . . .

"No!" boomed Pavel. "They don't affect the data. We go forward."

"I agree," Urowsky said. "There's a principle at stake now, and I won't yield it." Lucinda said nothing, content to let them have their way.

"Then maybe we can find the moles ourselves," said Jeong. "We can ask them, under the MEG. We'll be able to spot any lies by the Penn State method."

"So you want to treat our volunteers like criminals?" Pavel said.

"No, like suspects, because they are."

Urowsky shook his head. "That's going too far, Sam. We won't do it."

"What if we don't ask them directly?" Kate suggested. "I'm sure I can craft a

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few questions about the story and the protests, and make it seem like we're taking advantage of events to get readings on current controversies. They wouldn't have to know we were looking for informers. We could even get useful data out of it."

Pavel sneered. "So, violate their rights in secret. Yeah, that's much better."

The argument flowed back and forth, but Lucinda stayed aloof. Pavel's side won in the end. Lucinda felt like she had let someone down with her silence, but she didn't know whom.

A few applications of campus police presence finally broke up the demonstrations, with cries of repression from the accustomed radical sources. Then most of the weekly alternative paper's run was stolen before it could be distributed, and cries of violated rights rose from the conservatives. The controversy began spinning away from the lab into a conventional campus political dogfight.

One residual outcome was a wavelet of new volunteers, coming from the few weekly papers that reached the public. Their numbers more than compensated for the several dropouts, and they would eventually prove to offer the balance Lucinda had sought.

Lucinda didn't interview the new applicants. The schedule holes created by dropouts needed filling, and Friday was her turn to fill one.

It was strange, after so long watching other people be scanned, to undergo it herself. The chair felt stiff as she settled into it. The pads bracing her head were uncomfortably cool, but she grew accustomed to the pressures. The scanning apparatus looming over and around her felt like a weight ready to drop on her. She might have a few suggestions for future procedures once she was done.

Kate sat beside her, and after a few minutes of soft music to set a baseline, started asking questions. Lucinda knew most of them already, but still felt unprepared as she gave her opinions, her reactions, her rationales.

She felt exposed, talking about things she kept to herself or a few scattered friends. She couldn't help wondering whether Pavel was in the booth, watching the layers being peeled away, finding fresh seeds for arguments or fulcrums for leverage. She resolved not to watch his scan when his turn came. It would feel indecent.

Lucinda felt little better when she began studying and organizing the neural profiles. Peering into their intimate thoughts felt disturbing, even though they had volunteered. Strange that she had never felt this way before, looking into the minds of violent offenders, or drug addicts . . . or Josh.

But these traits before her, she told herself, were rational, well-adjusted—in most cases. They were thoughts she wouldn't be ashamed to call human. Her argument, though, didn't settle her qualms.

So she started by dissecting her own brain patterns. She examined which areas of the frontal lobe activated for certain topics, and which ones also tickled other lobes or deeper recesses of the brain. She noted how specific areas always lit up when she heard specific buzzwords for controversial topics: "abortion," "polyamory," "genemod," "intergenerational intimacy." Her brain seriously spiked on the last one, impulses shooting through the orbito-frontal cortex, across the cerebrum, and even into the limbic system.

Not many subjects from the early scans held the same opinions she did, so obviously they didn't have the same patterns. What soon became clear was that they weren't similar to each other. Most activity was still in the cortex, but it wasn't pinned down to specific structures within lobes, or always within the same lobes. Sex questions came the closest, but still showed wide variations in location.

The new scans that came in over the

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next week strengthened the evidence. The political, the intellectual, the truly complex thoughts seemed to work differently. The further one got from the inner, primitive brain, the more unique thought patterns became.

Did this explain all the anecdotes? Did political ideas, not moored to any specific area, just get accidentally swept up and imprinted into new brains? It was a mere hypothesis, and raised plenty of questions itself, but it was a start.

The results heartened Lucinda, and not just in seeing ethical dilemmas forestalled or a murky question becoming clearer. Her years on the project had shown her mounting evidence that the brain was as Pavel envisaged it, a purely mechanistic, deterministic organ. It was good to see brains as individual, as capable of free action, again. The evidence was modest, but she welcomed it.

She felt a few touches of sorrow: for Darjeane, who was counting on her; for Josh and the others, who could be restored, truly helped, by what they sought. At heart, though, she was glad the quest now seemed impossible.

"It's going to be tough," Pavel said, gazing intently at his monitor. "Tough, but not impossible. No," he repeated softly, "not impossible."

He had called Lucinda in to confer, but was treating her like a mild distraction. He was studying a dozen scan images, all of slightly different areas of frontal lobes. He overlaid some of them, and made notes on a pocket-comp.

"We could always try the brute force method," Pavel said. "Gather enough templates so that eventually, by law of averages, we get a contrary opinion using the same neural pathways."

"What if the numbers are against you? These patterns may be as unique as fingerprints, or DNA. You may never find an exact match."

"We don't need an exact match, Luci. We've performed dozens of overlays without exact matches."

"Yes," Lucinda said, "when much of the work was done outside the cortex. And those patients were gravely dysfunctional. Fixing those dysfunctions was paramount, even at the cost of causing alterations in their personalities, their politics."

"No. No, it's not a show-stopper, just a trade-off."

Lucinda was surprised. Any other time, Pavel would have risen to deny the old anecdotes. Had he seen some firmer evidence in those scans, enough that his half-hearted protestations didn't seem to convince even himself?

"A concentrated aversion therapy could do it," he said. "Get the right neurotransmitters flowing in the orbitofrontal when they hear things we want them to disbelieve, and they'll disbelieve them. Same with forming affinities. They'd be awake during the trans-cranial procedure, so—"

"So they'd build aversions and affinities for what else, Pavel? Anything they saw during the operation, like the color of the walls? Doctors? Do you want groupies that badly—or people deathly afraid of you?"

"They could keep their eyes shut . . . but okay, that wouldn't stop hearing, or even random thoughts that could get caught up in the changes. But if we put them under . . ." He said nothing for a few minutes, though his lips moved and his fingers gestured.

"All right, there's cross-mapping," he said, apparently discarding the aversion idea. "Find similar structures performing related tasks in different areas. For that to work . . ." He trailed off again. A moment later, he shook his head with a groan.

"It's all right, Pavel," Lucinda said. "There's no point in exhausting yourself if the problem is intractable."

He looked up sharply. "It isn't a matter of if, Luci. Nature always yields its secrets." Lucinda didn't want a tiff over quantum mechanics, especially in connection with the brain, so she held her

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peace.

"But nature doesn't have to make it easy," he admitted. "If I had an uninterrupted year with this problem, with more templates to study—a lot more—I could crack it. Probably."

"Is there any chance you'll have it cracked by tomorrow?"

"Tomorrow? Oh God, that's right. Her." He shook his head, defeated. "Sorry, but your mystery petitioner is going to have to be patient. Maybe very patient."

"This is all you can give me?" Darjeane Carson said, hefting the legal-sized pocket-comp. "Something, maybe, in a year or two?"

Lucinda nodded gently. "Barring sudden breakthroughs, yes. Pavel would say up-front if he had better prospects." Pavel had written most of the report Darjeane was reading, with snippets from Lucinda and Urowsky. "I'm sorry I couldn't send you back south with better news."

Darjeane re-crossed her bare legs, and studied the pocket-comp for a long time. "Maybe you can," she said. Her eyes wavered, not quite locking on Lucinda's. "Could you do this more easily if it were one specific thing, not a whole array of them?"

Lucinda thought. "It would simplify matters, but there'd still be the need to figure out the methodology to transfer any particular . . . thing."

"But you could concentrate your work on that one thing, move faster than if your efforts were spread out, right?"

Lucinda edged forward in her chair. "Ms. Carson, exactly what do you have in mind?"

Darjeane hesitated on the edge of speech. If this was acting, Lucinda though, it was excellent.

"I'm saying this only because I trust in your understanding, and discretion. If this were publicly connected to me . . . well, aside from everything else, there are still box office realities. It would limit my star potential to be so openly . . . oriented."

Before Lucinda could say anything, the words began cascading out of Darjeane. "You see, every star needs a breakout role. There's a project under development now that's got that role for me. It's perfect. I read the book, I empathize totally with the character, and the script hasn't changed her out of recognition, so I'll be able to play the part right. I've given readings; I've gotten callbacks. It's all working out.

"Except . . . there's this producer who controls the property. She's sat in on all my readings. She's taken me aside, told me how good I'd be in the role—but she's also told me, more than once, that I'm not doing everything I could to get the part."

Her breath came in a gasp. "She's done this before. I know five or six actresses who have gone to bed with her for roles. Names you'd know, Dr. Peale, whose careers have benefited. I want, I need that same boost—but I can't make myself do what I have to.

"I guess it's how I was raised, just another of those beliefs that have made me fit in so badly in Hollywood. I'm not sure I would have done it for a man, either, or maybe I never noticed the hints they were dropping. But I have to deal with what I've been handed. I have to be able to do this, whether it's just the one time, or whether the change is more . . . permanent."

Her smile, already sad, turned miserable. "Please don't look so shocked. I've been shocked enough for two people, I promise you. But I made my decision, and now that I can't hide it as part of an overall modification any longer, I'm sticking with it."

She reached over to touch Lucinda's hand, and it was all Lucinda could do to suppress a shiver.

"I want you to make me a lesbian, Doctor."

* * *

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Urowsky and Dreher came into the staff room together. "Luci, what's happened?" Urowsky demanded. "Why have you called this meeting?"

"Not yet, Steven. Not until everyone is here." She gave Dreher an apologetic look. "Sorry this is how we're bringing you into the team, Vera."

A moment later, Pavel came roaring in. "Luci, what is going on? I just got a video mail from your mystery actress, calling you every name in the book, saying you—"

"I can guess what she's saying, Pavel. If you'll sit down, I can tell you all what happened."

She told them in a few short sentences what Darjeane had revealed. She elided over her futile attempts to dissuade her, that had just made Darjeane disillusioned and then incensed at her lack of compassion. Instead, she just said, "I took the liberty of saying for all of us that we can't and won't perform such a procedure."

"And you had no right!"

Lucinda looked over at Pavel. "That's not all I did. I notified an old colleague at UCLA. Together we've warned every research team working on overlay about a person wanting a change of sexuality under duress, and urged them not to accommodate that person. I'm pretty sure UCLA will agree. We'll see about the rest."

She waited to see who would break the stunned silence. Thankfully, it wasn't Pavel. "Dr. Peale," LaPierre said, "you have gone far beyond your authority as part of this team. You and this secret colleague—"

"It's no secret. She's Frances Roselli. She's before your time here, Doctor, but some of the others remember her."

"In any event, the two of you presumed to speak for us all."

"We spoke for ourselves, Dr. LaPierre."

"Wrong." Pavel had finally regained his voice. "You spoke in all our names, especially to Ms. Carson—and you lied!"

"About what?"

""Can't and won't," you said. Both of those are wrong. We can do a sexual preference overlay."

"I wasn't aware the team had worked in that area," LaPierre said.

"We haven't," said Urowsky.

"It's not that difficult," Pavel insisted, fingertips touching his temples. "I can see it. It's mostly hypothalamic work. I'd have to damp activity in the ventromedial nucleus, probably raise it in the INAH3 nucleus, stimulate production of endorphin receptors in the right places. I can get details on the fine structures from scans we have on file. We have a couple of lesbians in the current pool: they said so in their political surveys."

Each sentence chilled Lucinda more. "Pavel," she said, "you're not going to do this."

Pavel looked at her. The intensity in his eyes almost knocked her over. "What's to stop us? Not our technology; not our expertise. Only reactionary fears, naked homophobia."

Lucinda shuddered. "Were you listening to what I said about Carson?"

"Absolutely. It was a real shock hearing you, worse than your scans suggested. You're blinded to the facts. Sexuality is hard-wired in the womb. The neural patterns are inherent. If you're too prejudiced to accept scientific reality, you don't belong here."

"Now wait—" Dreher's objection was stilled by a gesture from a resigned Urowsky.

Lucinda leaned in. "You've been studying neurobiology too long to be that simplistic, Dr. Petrusky. The path goes both ways. Actions create and reinforce neural architecture, the same as brain patterns producing actions. We're not just made by our minds, we make them."

Pavel rolled his eyes. "Free will again. Fine. If you believe that, you should have respected Ms. Carson's desire to create her own mindset. You should have permitted her to choose homosex-

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uality, instead of repressing her rights."

Lucinda shook her head. "You *haven't* listened to me. She's being exploited, coerced into abusive sex—and don't twist my words. You wouldn't tolerate this if a man were demanding she sleep with him to get a role. God knows the casting couch has been around in Hollywood long before this, probably before talking pictures. Now that there's a new wrinkle in the abuse, do you really—*really*—think that's progress?"

She sagged, her arms on the table barely holding her up. "I thought we were working to prevent abuse, not perpetuate it."

Pavel's jaw trembled. "It wasn't your call to make."

She straightened with an effort. "You're the one who said scientists should be in control. Well, now they are: all of them, not just our little group. I gave them the facts, and I have to trust they'll do the right thing with them."

"You didn't trust me."

Lucinda turned toward Dreher. "Pardon?"

"I thought you brought me onto the team to evaluate people in situations like this," Dreher said. "Instead, you took it upon yourself. I wasn't much in control, was I?"

Lucinda's heart fell. "Oh. Vera, I wasn't even thinking about you. I'm so—"

"Wrong," Pavel said, softly but sharply. "Every assumption you've made, wrong."

"I assumed this team wouldn't assent to what Ms. Carson requested. Is that wrong?" She looked at everyone at the table. "Is there any question this is unethical? Would any of you, knowing what you do, really have agreed to this?"

Pavel put up his hand. Sam shook his head hard. Everyone else hesitated. Lucinda saw fractional head shakes from Barber and Dreher, but nothing full-blooded. "Dr. Urowsky," she said, arms wide in appeal.

"My misgivings are not the issue, Dr. Peale. You acted without our consent, without even informing us, regardless of what you believed we would decide."

Lucinda took a moment to reply. "You're right. A few hours' delay to consult with you probably would not have affected anything. I acted too precipitously, and for that I apologize."

"Apologizing isn't enough," Pavel said. "We have to reverse your actions. You and Roselli have to rescind all the messages you sent out. You personally have to tell Carson you're reconsidering, and then we have to actually reconsider, once passions have cooled. That'll be a start."

"No," Lucinda said. "I'm sorry for my haste, not my convictions. What you're proposing is an implicit reversal of policy, and approval of sexuality rewrite. It would be the start of the gross misuse of neural overlay, the gateway to abuses I don't even want to contemplate. We need to take a stand on ethics, and this is the time."

I shouldn't have even let it come this far, she thought. *I've tried to avoid controversy. Now I have to embrace it. Let's see how well I can play Pavel's game.*

"If you decide to reverse me," she said, "it moves us in an ethical direction I cannot follow. I won't be able to work on this team any longer if that happens."

There were frowns across the table, one deeper than the rest. "That's blackmail," Pavel said, "threatening to leave if we don't approve your unilateral action."

"Really? Remember when you threatened to leave if Dr. Urowsky wouldn't operate to clear your stutter?" From the corner of her eye, she saw Dreher looking from one person to another, as if wondering what she had gotten into.

"That was just me," Pavel said. "It didn't leave this room. What you've done has already spread across the country. Our reputation's at stake."

"I couldn't agree more," said Lucinda. "Holding this ethical line is more important than what it could cost me. If to feel justified in retaining this stance, you

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have to discipline me—or dismiss me—that's a price I accept."

Her legs wobbled a little. The suddenness of it all had left her dizzy, but she didn't feel any regret over what she had just said.

Urowsky leaned his chin onto his hand. "We need to discuss this matter, Dr. Peale. I have to ask you to step outside."

"Of course. When you need me again, I'll be in my office." She turned, feeling steadier on her feet, and left the room.

Lucinda had one of the pedophiles' brain scans on her monitor, next to a potential donor template. She traced pathways between the hypothalamus and cortex with a light pen, the paths lighting up in both brains. Overlay this, interrupt that sexual ideation, and a monster regained control over himself.

It was a fairly routine analysis these days, but Lucinda drew solace from it. This was work she could do without dread.

She heard a knock, and looked up to see Pavel at her door. "I'll be right in," she said.

"The meeting's over," said Pavel, his mouth turned down.

"Oh." It sank in for a moment. Quite calmly, she pulled over a box in the corner, emptied it of the paper files it held, and started opening desk drawers.

"What are you doing, Luci?"

"I'm packing up my things, Dr. Petrusky." She didn't look at him. "If they sent you, I'm pretty sure I know what they decided. Congratulations."

"We're not doing the procedure," Pavel said through a tight throat. "And you're not out of the program . . . not if you don't want to be."

Lucinda turned slowly Pavel's way. "What does that mean?"

"It means we're going to be keeping a very close watch on you. We'll be monitoring your outgoing e-mail and Netphone use, so you don't go around us again. We'll also be sifting through all the computer records you've handled, all the data, to see if there's anything you may have . . . adjusted."

"What?" Lucinda's face burned. "If you distrust me enough to think I may have falsified data, how can you trust me enough to let me keep working here?"

"If the records are clean, that'll show we can trust you."

"I see. And what else?"

Pavel wore what could have been a grimace, or a smile. "You will make no more comments about Ms. Carson or the sexuality overlay to anyone, even people you've already informed, even if they ask you directly. The whole team will be silent about it, at least until our ethics committee makes a long-term decision."

"That sounds about—" She stopped in mid-nod. "'Our' committee, you said?"

"Yes. That's a bit of good news for you: we're formally creating the ethics committee you wanted."

Lucinda read through him. "And I'm not on it. And you are."

Pavel nodded. "Myself, Dr. Urowsky, and Dr. Dreher."

"Dreher? On her first day?"

"Almost her last day. Urowsky and LaPierre had to work fast to keep her from quitting the team after your outburst."

Lucinda ignored the jab. "What about Kate? She and I interact the most with the subjects. We'd be ignoring that connection."

"That's Dreher's province. That's why you wanted a psychologist on the team, isn't it?"

She subsided at that, outmaneuvered again. "How many of these conditions were your ideas, Pavel, your ways to chastise me?"

Pavel went stony. "I won't discuss deliberations made behind closed doors. There was a reason we asked you to leave." He softened. "I do hope you will stay, Luci."

"Do you really care?"

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Her sharp words put him back on his heels for an instant. "It would hurt us t- to lose your talents. There's no reason you can't do your work here as well as before, or better, if you can put aside your politics."

Lucinda arched her eyebrows. "In favor of yours?"

"You'd be better off—but no, I don't imagine you'll come my way. That's plain now." Pavel's face was stone again. "You have the weekend to decide whether you'll accept our conditions for staying on, Dr. Peale. Please don't take any longer." He marched out without a backward glance, swinging the door shut with a firm thud.

"I said, do you hear me, Doc?"

"Hm?" Lucinda lowered her roller and looked dully down from her ladder at Josh. Only when a drop of paint fell past the brim of her cap did she snap into full awareness. "Sorry, Josh. What did you say?"

"I asked you what was wrong. You've been morose all day and yesterday. More so than me, and that's saying something."

She had been dwelling on things, and Josh had just broken up one of the deeper spells. "It's . . ." She started working on the ceiling again, to give herself a moment. "I tried to do something at work, thinking I was protecting someone. I may have made matters worse."

She wasn't convinced, but she certainly felt like she had lost more by her precipitate actions than she had gained by taking a stand. Each day, she half-expected to hear that Darjeane Carson had gone public, made an open controversy of it. She more strongly expected that Carson would quietly find some institution, maybe in America, maybe in Europe, that wouldn't have the scruples she had exhorted, at such cost. She might have paid only for a short delay.

"Someone in the program, I assume," said Josh. "Someone you've already. . . ?"

Lucinda saw where he was going. "No, not one of our subjects," she said, meaning *Not you*. That satisfied him, and he went back to his edging work.

The irony was, her disgrace at work made it more certain that research on political overlays would go ahead, and that Josh might someday get those unwonted ideas out of his head. Could she even begin to explain her qualms to him, why she would have sacrificed his benefit for something larger?

If he ever got the opportunity, though—if Pavel's panel judged his case worthy—she wouldn't try to stop Josh. She'd tell him what was possible, give him the chance. Something good had to come of this, especially when the bad things seemed all but sure.

Those thoughts occupied her as they finished painting the main bedroom, the final room they had to do. Four weeks of disruption were finally over. Now, maybe, Lucinda could have a place again where her life felt normal.

They moved the ladders and other equipment into the hall, and started folding the dropcloth between them. "Doc," said Josh, "I want to thank you again for thinking of me. This job's been a real help."

"You've been a help, Josh, even if you keep calling me 'Doc.' That just doesn't sound right. Anyway, you deserved the opportunity."

"That's nice of you to say. This'll definitely help pay for that electronics course, and it doesn't hurt that it got me out of the house." The little he had said about his parents' fights in the last few weeks made it sound like they wouldn't both be in that house much longer.

"But I still want to show my appreciation . . . Lucinda." He took the corners of the thrice-folded dropcloth from her hands, to finish the folding himself. "Let me take you out somewhere for dinner, to celebrate our completed project."

Lucinda gave a small gasp, trying not to make it sound like a laugh. "Josh, are you—"

Josh froze for a second, blinking,

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holding the dropcloth in front of his chest. "Uh, after we've cleaned up, of course." His eyes dropped to his spattered clothes. "Oh, but my good stuff's at home, and I can't go out looking like . . ."

A growling moan outside saved him. "Tell you what," he said, setting down the folded dropcloth. "You close off the room, and I'll let Ben in." He hurried into the hall and down the stairs.

Lucinda took a breath. She was reading too much into this. Josh was just trying to re-socialize. He had been conscientious about reversing the passive, isolated patterns of behavior from his years of schizophrenia.

He couldn't have other things in mind. Less than a year ago, he had asked her whether he could have his sex drive erased. No woman, he said, could understand and forgive his past, could trust him not to be violent again.

No one, perhaps, except the woman before whom his mind had been laid bare, who knew all his most horrible secrets—and not only hadn't shunned him, but had shown trust in him.

Suddenly, that confrontation Josh had with Pavel a couple of weeks ago made sense. Then things shifted, and it made sense in both directions. Of all things never to suspect . . .

She heard feet pattering downstairs. She moved anything that might be too messy into the bedroom and shut the door, just before Ben came trotting upstairs.

Josh was close behind him. "Yeah," he told the dog, "you'll have the whole house back soon, pal. You'll love that." He gave Lucinda a crooked smile. "Anyway, uh . . ."

"You're probably right," she said. "It's a bad day for it." She watched him sag and nod. "What time does your shift at the municipal building end?"

"Huh? Oh, tomorrow? Six in the evening. I'm finally on day shift."

"Good. I can get out of the lab at a decent hour, and pick you up for dinner. Oh, and I'll pay, Josh. Consider it a tip."

After a moment of bewilderment, Josh said, "Sure. Thanks again, I guess." His eyes moved off her fast, and found Ben. He knelt to give Ben a rub behind the ears.

Lucinda watched them both. *Pavel was wrong*, she thought. *You're not a pet, Josh. You're not a plaything. I will remember that.*

She wished she could talk to Dr. Dreher, get an opinion from someone more objective, yet still connected. Vera surely wasn't in a mood for such a conversation, though. She might even think it something for the ethics committee, if Lucinda had completely alienated her, if she had gone wholly into Pavel's orbit. Lucinda was alone on this.

No, you aren't. Josh has his own mind, his own moral center. Our work has done him that much good.

It had done a lot, if she could consider even the possibility of getting closer to Josh. It had done as much for scores of people, many worse off than he.

It was that thought that made her decide to stick with the overlay team, if she could stand it. She had to do as much good as she could for their patients, and to counter the attraction of dubious and dangerous ethics as long as she was able. Such fights wouldn't make her popular, but she had already crossed that line from passivity and avoidance of conflict. She could go forward or retreat, and she chose forward.

There was some of that attitude she could apply to Josh, too. Try to do good for him, keep his best interests foremost in her mind, whatever they were, and she couldn't go far wrong. That applied both professionally and personally.

He might appreciate the irony, Lucinda realized as she watched Josh and Ben playing in the hallway. After all the horrible deeds of his youth, he was going to be her conscience. ■

(EDITOR'S NOTE: This story is a sequel to "A New Man" [October 2003].)

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SCIENCE FACT

THE PREHISTORY OF GLOBAL CLIMATE CHANGE

Richard A. Lovett

"Prehistoric" does not mean "irrelevant now"!

In 1994, a research team led by Kirk Johnson, curator of paleontology at the Denver Museum of Nature and Science, discovered the fossil remains of a 64-million-year-old forest in a roadcut near Denver, Colorado. Since then, the scientists have identified 170 species of plants in this forest, some with leaves up to twenty-four inches long. Many of the leaves had long, narrow tips—called *drip tips* by biologists.

Such leaves shed moisture more easily after a rainfall, allowing them to drip-dry between showers, so they don't provide moist surfaces for moss or parasites. They serve no purpose in present-day Colorado, where excess moisture is rarely a problem. Rather, they're only found in rainforests receiving 100 or more inches of precipitation per year. The conclusion: 64 million years ago, Colorado was much warmer and wetter than it is today.[1]

The study of ancient ecosystems is called paleoecology, and in today's world, when global climate change is an international concern, it is of more than passing interest. By studying how plants

[1] For details, see Kirk R. Johnson and Beth Ellis, "A Tropical Rainforest in Colorado 1.4 Million Years after the Cretaceous-Tertiary Boundary," *Science*, 28 June 2002, pp. 2379-2383. Additional information comes from a lecture that Johnson gave at the 169th National Meeting of the American Association for the Advancement of Science (AAAS), February 13-18, 2003, in Denver. This climate change wasn't merely the result of millions of years of continental drift. Sixty-four million years ago, Colorado was located at very close to the same latitude as it is today.

[2] Why this dividing line isn't called the C-T boundary is something of a mystery, although it probably has something to do with preventing confusion between the Cretaceous and a prior epoch called the Cambrian.

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Table 1: Geological Timeline

Era	Period	Epoch	Starting Date (Mya)[a]	Selected Highlights
Cenozoic	Quaternary	Holocene	0.01	Science fiction magazines.
		Pleistocene	1.8	Ice ages.
	Tertiary	Pliocene	6	
		Miocene	24	
		Oligocene	37	
		Eocene	58	
		Paleocene	65	Rise of mammals.
Mesozoic	Cretaceous	Each period is divided into numerous epochs	135	K-T extinction. Big dinosaurs.
	Jurassic		208	
	Triassic		248	Small dinosaurs.
Paleozoic	Permian		290	Permian extinction.
	Pennsylvanian		320	Carboniferous swamps.
	Mississippian		355	Ice ages.
	Devonian		410	Age of Fish.
	Silurian		438	Land plants.
	Ordovician		505	
	Cambrian		545	Trilobites.
Precambrian	Ediacaran[b]		600	Filter-feeding animal communities on seafloor.
	Proterozoic Eon[c]		2,500	Ice ages may have reached equator, creating "Snowball Earth." Photosynthesis adds oxygen to atmosphere.
	Archean Eon		3,900	Earliest life.
	Hadean Eon		4,500	Earth formed. Not a friendly place.

[a] Precise dates of some periods are open to debate.

[b] Readers familiar with the geological timeline may not recognize this period. In May 2004, the International Union of Geological Sciences recognized the Ediacaran as a separate period (rejecting a Russian plea for the alternative name "Vendian"), carving it out of what had previously been part of the "upper" or "neo" Proterozoic. It is the first new geological period to receive official recognition in 120 years.

[c] Eons are bigger divisions than periods, but not as big as eras.

and animals responded to prior climate upheavals, paleoecologists hope to shed light on what might be in store for us in years to come.

Big Nasty Rocks, Volcanoes, and Thermal Maxima

The world has seen many climate changes, but the most famous occurred 1.4 million years before Johnson's rainforest, marking the division between the Cretaceous and Tertiary periods of geological history (see Table 1). Called the K-T boundary, it's best known as the end of the age of dinosaurs.[2] But dinosaurs weren't the only species affect-

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Table 2: Climate Changes in late Cretaceous and early Tertiary Period

	K-T Event	PETM	IETM	Permian Extinction
Date[1]	66 Ma	56 to 43 Ma	52 Ma	150 Ma
Probable cause	Global warming followed by a big, nasty rock from space	Global warming spanning several million years	Rapid spike in global temperatures due to greenhouse warming from large methane hydrate release. More gradual return to baseline	One-two punch of uncertain origin. Volcanism and an asteroid strike?
Short-term effects	Massive extinctions	Species survival	Increased species diversity due to intercontinental migrations; few extinctions	Extinction of 90 percent of ocean species; destruction of terrestrial woodlands
Long-term effects	Species diversity reduced for millions of years. Opened door for age of mammals.	Warming associated with increased species diversity	New animals dominate North America. Little impact on plant communities.	Woodland recovery delayed for 4 to 5 million years.

[1]Ma is paleoecological shorthand for "million years ago." Some scientists use m.y.a. instead.

ed. In a geologically short period of time, something on the order of 70 percent of the Earth's species went extinct.

The K-T event is best studied in contrast to three other global climate changes that occurred between 150 and 43 million years ago: the Paleocene-Eocene Thermal Maximum (PETM), the Initial Eocene Thermal Maximum (IETM, which was a separate event early in the PETM),[3] and the Permian Extinction. The three events, plus the K-T extinction, are summarized in Table 2. Let's examine them in historical order.

The Permian extinction was the most massive die-off in the history of the Earth, but because it didn't involve dinosaurs, it's not as well known as the K-T extinction. Its cause is subject to debate. It is known, for example, that this was an era of extraordinary volcanic activity in Siberia. This volcanism (which has no parallel in human history) would have thrown massive volumes of ash into the air—enough to considerably impact the Earth's climate. Another hypothesis is that the Earth was hit by an asteroid. (As this article was going to press, geologists were excitedly announcing that they may have found the impact crater on the seabed, near Australia.) Or perhaps the cause was something more prosaic. Whatever happened, paleoecologists estimate that 90 percent of marine species and a goodly fraction of terrestrial species died.

Cindy Looy of the Laboratory of Paleorotany & Palynology, Utrecht Universi-

[3] As if the PETM and IETM aren't hard enough to keep straight, the terminology in the scientific literature isn't always consistent. Some scientists use IETM as a synonym the PETM. In this article, I have made every attempt to use distinct nomenclature for the two climate events.

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ty, The Netherlands, has examined fossilized pollen and plant spores trapped in sediments laid down before and after the Permian event. She found that before the Permian extinction, the world was dominated by conifer and seed-fern woodlands. After the collapse, the woodlands disappeared—so thoroughly that it took four to five million years for them to reestablish themselves. But, interestingly, the collapse wasn't immediate but instead stretched out over perhaps 200,000 years. This may indicate that the Permian ecosystem received a one-two punch. Perhaps the Siberian volcanoes weakened the ecology enough for a subsequent asteroid strike to clobber it more thoroughly.[4]

The K-T event also appears to have involved two distinct causes. For about a half-million years, the Earth had been warming—rapidly by geological standards. Johnson and Peter Wilf of Pennsylvania State University have studied more than 22,000 plant fossils from this era, looking for last appearances of each species. A significant fraction of the species that went extinct appear to have done so slightly before the K-T boundary, during the period of rapid-but-not-catastrophic climate change. Then something happened, and a great many more species went extinct virtually overnight. Prevailing theory is that the coup de grace was an asteroid strike in Mexico's Yucatan Peninsula. As in the Permian, the Earth was slow to recover: terrestrial ecosystems remained impoverished (from a species-diversity perspective—Johnson's forest indicates that surviving species could still produce a dense rainforest) for at least a million years after the asteroid impact.

The Permian and K-T extinctions give us our first paleoecological lesson, and it's a sobering one: if you damage the Earth's ecosystems badly enough, it takes a very, very long time for species diversity to recover.

The PETM came after the K-T recovery and offers a quite different lesson. The "thermal maximum" was the result of a steady warming trend extended over an interval of several million years—roughly from 55 to 43 million years ago.[5] The PETM produced unusually warm climates, worldwide, but was not punctuated, as Wilf likes to say, by the K-T's "big, nasty rock from outer space." Nor was it a period of mass extinction. Most plant species sailed through the transition—changed in habitat range and relative abundance, but not wiped out. The lesson here: ecosystems adapt much better to slow climate changes than to fast ones.

Unfortunately, Wilf doesn't see this as providing great reason for optimism about our own future because, from a geological perspective, human activity has been nearly as sudden as a meteor strike. In addition to the much-discussed threat of global warming, humans endanger plants and animals in much more mundane ways such as habitat destruction, pollution, and fragmentation of ecosystems by highways and parking lots. Even our penchant for plowing farmlands or bulldozing soils for home construction may play a role: in a study published online in 2003, Ron Amundson, a soil scientist at the University of California at Berkeley, has cataloged "endangered" soil types and linked them,

[4] Looy presented her results at a paleoecology symposium the 2003 AAAS National Meeting. Unless otherwise specified, other findings discussed in this article were presented at the same symposium.

[5] Ancient temperatures can be determined from the isotope ratios of oxygen in limestone deposits. At different temperatures, the seashells that form these rocks contain different levels of oxygen 18.

[6] Ronald Amundson, Y. Guo, P. Gong, "Soil Diversity and Land Use in the United States," *Ecosystems*, 24 July 2003 (Online First version).

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statistically, to endangered plant species.[6] "The current situation," Wilf warns, "is more like the K-T boundary than the Paleocene-Eocene one. We could easily be looking at mass extinction of half of our plant species over the next 100 years."

The IETM, however, indicates that ecosystems can tolerate fairly rapid change—although it should still be noted that the IETM wasn't really all that rapid by human standards. This thermal maximum was a spike of particularly warm temperatures embedded in the overall warming of the PETM (which we'll discuss in a moment). The IETM occurred 55 million years ago and corresponded to a warming of between 4°C and 8°C at high latitudes (7°F to 14°F) occurring over the course of no more than 10,000 to 20,000 years. (The transition might, in fact, have been even more abrupt, but 10,000 to 20,000 years is the limit of geologists' ability to resolve that change in rocks laid down so many millions of years ago.)

Most likely, the warming was triggered by a massive release of methane hydrates from the sea floor. (The evidence for this comes from an increase in the amount of carbon-13 in rocks formed during that period, a change that geochemists can only explain via the methane hydrate theory.)[7] Such hydrates currently reside on the ocean floor, and in theory, a sufficiently large disturbance could cause them to rise to the surface, where they would disassociate into methane and water. One way this could happen would be if the slower warming of the PETM reached a critical level that allowed the release of hydrates. (Some scientists worry that the same thing might happen today.) Or maybe a comet strike or enormous earthquake disturbed the ocean bottom. Whatever started the process, once the hydrates were disturbed, large amounts of methane—a powerful greenhouse warming gas—were released to the atmosphere.

The result was a dramatic short-run change in climate. It didn't last forever, but it took 80,000 to 100,000 years for the methane to disperse and the climate to return to "normal" PETM levels. And meanwhile, the IETM warming had allowed a dramatic change in the mammalian species present in North America. Sixteen new genera of mammals appeared in Western North America, coming to represent half of the total mammalian population. These included ancestral pigs, dawn horses, and primates. (Many of these later went extinct, but that wasn't until much more recently.) Most likely, Wing says, these animals migrated to North America from Asia, via polar land bridges previously blocked by harsh winters.

Normally, invasive species are thought of as destructive—crowding out the natives or out-competing them for crucial resources, just as rabbits and wild dogs have wreaked havoc in Australia. But actually, only a small minority of nonnative plants and animals are destructive. In the Eocene, the pigs, horses, and other large animals merely added themselves to the existing ecosystem, increasing its diversity.

Interestingly, plant species did not show a similar intercontinental spread. A few reached North America from Asia, but for the most part they never became abundant. Why the difference? One reason is that plants also had to migrate across high-latitude corridors—seeding and reseeding themselves along the route.[8] Even if the poles had warmed up

[7] See S. L. Wing, P. Gingerich, B. Schmitz, and E. Thomas, eds., *Causes and Consequences of Globally Warm Climates in the Early Paleogene*, Geological Society of America Special Paper 369 (undated).

[8] Those whose seeds could have blown long distances on the wind would have arrived long before.

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considerably, these plants would still have had to contend with the long, dark winters. For many, that itself may have been a major barrier. In addition, Wing notes that the PETM had already given the Eocene a very warm, wet climate. Even if a plant managed to cross a land bridge, it might have had difficulty finding places to grow in the dense forests that dominated the era's ecosystems.

Overall, Wing says, there are three important lessons that can be drawn from the IETM:

1. Greenhouse climates can change very rapidly. "That's sobering," he says.

2. Animal species can change their ranges rapidly in response to climate change, with permanent alterations of the resulting ecologies.

3. Plant migrations aren't always rapid (although rapid spread is possible).

Yo-Yo Seas . . .

Let's now roll the clock further back to the Pennsylvanian Period of the late Paleozoic.

It was the era, 300 million years ago, in which coal seams (including those of—guess where?—Pennsylvania) were formed from vegetation buried in swamps, an era when both America and Europe lay near the equator. It was also an ice age, and as the polar ice caps waxed and waned, sea levels fell and rose, causing the ocean to cyclically retreat and advance from the coastal plains in which the coal was being formed. This had two effects. First, the shifting sea alternately wiped out the swamp ecosystems and exposed ocean bed on which new ecosystems had to develop from scratch. Secondly, the cyclical infusions of salt water percolated into the coal beds and preserved detailed cellular structures of the buried plants. The result is a bonanza for paleoecologists. It's even possible, says Wing, who with his colleague Bill DiMichele has studied many of these coal beds, to tally what fraction of the ecosystem's biomass was comprised by each species.

The overall picture is one that's been known for many years. The swamps were woodland ecosystems comprised of a more alien-looking mix of vegetation than that found in many science fiction stories: landscapes dominated by giant clubmosses, giant horsetails, conifers, seed ferns, and tree ferns.

But for paleoecologists, the most interesting observation is that with each advance and retreat of the ocean, the same groups of species returned, forming very similar ecosystems, again and again and again. Apparently, the swamp species were simply shoved to new, inland habitat, from which they could revegetate the coastal plains once the oceans withdrew. It's a reminder that while individual plants can't get up and walk away from danger, plant species are mobile and can save themselves by reseeding to new, now-suitable habitat. This offers some reassurance for our own future. Humans, after all, are very good at moving plant and animal populations around. If we drive species out of their current environments, we'll do our best to establish them in new environments (presuming, of course, that suitable environments exist).

The coal swamps of the Pennsylvanian Period, however, were comprised of species that could spread easily enough not to be wiped out by the ocean. (Those that couldn't would have been eliminated by its first advance.) Not all plant communities are so easily mobile, even when humans try to extend their range. A collection of mini-ecosystems near Merced, California, offers a disturbing case in point. Considered by ecologists to be one of the world's most important biodiversity "hotspots," the Merced region is a complex mosaic of meandering river channels, ridges, low basins, and vernal pools. Each segment contains a unique soil, deeply enough linked to individual plant communities that people working to preserve endangered plant species have found it diffi-

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cult to transplant them, even to closely related soils.[9]

Near its end, the Pennsylvanian Period went through a transition from a subperiod known as the Westphalian to one called the Stephanian.[10] During the Westphalian, the coal seams revealed forty-eight plant species, of which thirty were trees and eighteen were groundcover. It was this collection of plants that persisted for millions of years, through each cycle of ocean advance and retreat. But something happened at the transition from the Westphalian to the Stephanian. The species composition suddenly shifted, changing to only seventeen types of trees and twenty-five types of ground cover. Even more significantly, more than half of the species present in the Westphalian swamps weren't among those in the Stephanian swamps. Overall, the mix of species revealed a change from a canopied forest to a more open one. What happened?

Apparently, Wing says, the tropics had become drier, perhaps developing a longer, harsher dry season than was seen during the Westphalian. One theory is that this was caused by a change in the South Polar ice cap. That would have altered the flow of moisture, which, in a phenomenon called *intertropical convergence*, is pinched away from the ice caps toward lower latitudes.

The change in the South Polar ice cap appears to have been short-lived, but by the time the tropics regained their normal moisture, the new plant species had become well established, and the old ecosystems never returned. The lesson is the converse of that from the IETM, and yet another warning for humans: a geologically short-lived climate change can sometimes cause irreversible ecological change.

. . . and a Sheltered African Valley

Irreversible ecological changes aren't necessarily bad for humans. In fact, a similar climate shift may have spurred the emergence of our ancestors. Let's set the paleoecological way-back machine on fast forward and zoom from the Pennsylvanian to the African Rift Valley between 3.5 and 1.5 million years ago.

At the start of this era, the Rift Valley was largely comprised of canopied forest. Early hominids were present but genus *Homo* had yet to appear, and *Homo sapiens* was still far in the future. By the end of this era, much of East Africa had dried to a brushy grassland, and genus *Homo* was firmly established.

Anna K. Behrensmeyer of the National Museum of Natural History has studied the link between these two changes. Her research centers on the Gulf of Aden and the Omo River Valley of southern Ethiopia. The Gulf is an arm of the Red Sea that collects wind-blown dust from the Sahara Desert. Core-drilling[11] allows sedimentologists to determine the climate history of the Sahara, both by the quantity of dust and by the isotope ratios of oxygen trapped in the sediments, which is an indicator of the temperature at which they were deposited. These core samples reveal that at the start of this era, northern Africa's climate was warm and stable. Then, it be-

[9] Amundson, Guo, and Gong, *ibid.*

[10] "Westphalian" and "Stephanian" are the European names for these geological epochs. In the U.S., the Stephanian is divided between the Kasimovian and Gzelian epochs, while the Westphalian overlaps the Moscovian Epoch and part of the Bashkirian. The European terminology, however, is often used in the U.S., especially when it is more convenient to speak in terms of only two epochs rather than four. Either way, the time period spans roughly 25 million years, from 315 Ma. to 290 Ma.

[11] I wrote about this in detail in "Sedimentology Gone Wild: The Onion-Layer Theory of Time Travel," *Analog*, September 2002, pp. 52-63.

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came cooler and more variable.

In the Omo Valley, paleontologists have recovered 1,400 hominid specimens—enough to allow a pretty good determination of which hominids were present at what times. The fossil record also shows much about the other plant and animal communities populating the valley, and digs have been conducted at enough sites to allow researchers to map the ecologies represented by each of the region's sedimentary strata.

The valley is a paleontologist's paradise, with many layers of floodplain deposits interleaved with layers of volcanic ash. That ash can be dated by two methods: the decay of radioactive elements contained in it and *paleomagnetism*, which detects the imprint of the Earth's magnetic field in rock strata, using changes in that field to determine the era in which the rocks were formed.

Paleontologists find that the Omo Valley was teeming in wildlife, much of it now extinct: large antelope, giant pigs, monkeys, etc. Overall, Behrensmeyer's team has divided the valley into four broad types of ecosystems; canopied forest, open woodland, wet grassland, and a drier, brushy grassland. Pigs and monkeys thrived in the dense forest; different pigs, monkeys, and an extinct form of kudu lived in the more open woodlands. The wet grasslands drew buffalo and waterbuck; the brushy grasslands drew pigs and baboons, along with wildebeest and other antelope.

Not surprisingly, the extent of these four ecosystems changed as the climate shifted. For the first million years, from 3.5 to 2.5 million years ago, the change was gradual, producing a slow shift from canopied forest to open forest, wet grassland, and eventually to dry grassland. But the Omo Valley was sufficiently well protected from the climate changes afflicting the rest of North Africa that all four ecosystems continued to exist—preserving substantial tracts of canopied forest, which provided habitat for forest-dwelling animals, including protohumans.

About 2.5 million years ago, the valley's ability to buffer the effects of neighboring climate changes was exceeded and its own climate became more unstable—subject to erratic swings vaguely comparable to (but much milder than) the repeated ingress and egress of seas in those Pennsylvanian-era coastal plains. The shift from stability to variability occurred quite rapidly, but there still wasn't a complete elimination of the canopied forest. Remnants persisted, providing refugia in which the forest dwellers could continue to exist while the land around them changed.

The climate change put pressure on the protohumans, but the refugia gave them hundreds of thousands of years to adapt. Major adaptations were needed because the increasingly open habitats adjacent to the refugia were much more complex and dangerous places to live than the canopied forests. It is during this time that the first members of genus *Homo* began to appear, along with the first artifacts. Shortly after that, *Australopithecus*, a human precursor that had previously been quite widespread, disappeared from the Omo Valley.

Perhaps, Behrensmeyer says, it was climate change occurring at just the right pace that led the early hominids to develop into cultural beings—beings who could work together for defense and food-gathering, beings who could manufacture tools and teach these skills to their children, beings who would eventually erupt out of Africa to colonize the globe . . . and eventually worry about changing its climate.

Not-So-Paleo—Ecology

Beginning in about 1910, the American West experienced a string of unusually wet years, affecting everything from California's Mojave Desert to the sagebrush steppes of eastern Oregon and Washington. The Great American Desert wasn't exactly squelchy, but there was enough water for farming, and home-

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steads and agricultural communities sprouted everywhere, like spring mushrooms.

Then the climate reversed, not merely returning to normal but overshooting into the Dust Bowl drought of the Great Depression. The farmers disappeared like tumbleweeds on the desert wind. Dust storms blew topsoil as far away as the Atlantic Ocean. Okies lined the highways to California. John Steinbeck wrote *The Grapes of Wrath*.

Can all of that happen again?

In the deep paleoecology we've been discussed so far, such changes occur too quickly to show up in the fossil record. But there's another branch of paleoecology that examines more recent climate history, and it has the ability to resolve changes that occur over human-scale time intervals. It can't tell us whether the Dust Bowl might repeat, but it does give us the disturbing news that even by fairly recent standards, the Dust Bowl was a *minor* drought.

One way of studying prehistoric climates is by looking at the growth rings on trees. The oldest trees in North America are bristlecone pines dating back about 5,000 years, but they live only on isolated mountaintops in Nevada, Utah, and southeastern California.[12] For broader climate records, you need trees that are more widely dispersed, even if they're not so old. One good candidate is the juniper, which can live 750 or so years and is common throughout the West.

These and other old trees indicate that shortly before the first Europeans reached North America, the continent went through a drought considerably more severe than anything in its recorded history. That drought lasted for several decades and stretched from Central Mexico to Montana, from the Rockies to Virginia. And, looking back to the Fourteenth and Fifteenth Centuries, scientists have seen even longer and deeper droughts. The Dust Bowl was economically devastating, but a repeat of any of these droughts would be far worse.

Tree-ring studies are only one way of getting a detailed view of prehistoric climates. Another is by studying pollen grains trapped in bog and lakebed sediments. In eastern Michigan, for example, there are bogs that have existed for 3,500 years. The bogs show an interlude in which there was a sudden switch in tree pollen from beech to pine, plus an increase in the amount of charred wood: a sign of forest fires. These indicate that at one point during the history of the bog, eastern Michigan dried up swiftly (over the course of only a few decades), then stayed dry for 1,000 years. By human standards, that's more than just a drought: it's a long-term climate change, and not one most of us would see as being for the better.[13]

Scientifically, the bog studies are important because they have helped change old theories of plant succession, which posited a gradual change in plant communities, as each ecosystem slowly prepared the way for its successor. Supplemented by insights gained from

[12] Horrifyingly, the oldest tree on Earth was cut down by a scientist in 1964 (with the permission of the U.S. Forest Service) when his coring tool broke. The tree, whose stump is now contained in Great Basin National Park, Nevada, was 4,862 years old, and still growing at the time. For more on the fascinating subject of tree-ring dating, called dendrochronology, see "If a Tree Falls . . . The Secret History of Global Environmental Catastrophe.", by Catherine Shaffer, *Analog*, December 2003.

[13] Michigan isn't the only place to show such changes. Four thousand years ago, Illinois and Iowa had extensive sand dunes. That was followed by a 1,000-year wet cycle.

[14] See Richard A. Lovett, "Up in Smoke: How Mt. St. Helens Blasted Conventional Scientific Wisdom," *Analog*, April 2001.

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watching the recovery of Mt. St. Helens after its cataclysmic 1980 eruption,[14] the bog studies support a new theory of ecological change, which says that ecosystems shift, not gradually, but in staccato jolts that occur when something overwhelms an old ecosystem and forces rapid transformation.

In a typical forest, what probably happens is that the preexisting ecosystem is hammered by few years of drought, says Steve Jackson, a paleoclimate researcher from the University of Wyoming. As dying trees topple, the drought literally punches holes in the old ecosystem, giving drought-tolerant species openings to invade. Soon—quite soon by the standards of the "old" ecology—we have an entirely new forest. Rather than the slow, "buffered" changes that Behrensmeyer saw in the Omo Valley, many of these recent ecosystem shifts are more like the shift in vegetation that occurred in the tropical coal swamps at the end of the Westphalian era—only much, much more rapid.

Such changes aren't limited to prehistory. Jackson knows of a region in New Mexico where a 1950s forest fire killed off a stand of ponderosa pine. Today, trees are growing back, but they aren't ponderosa. They're junipers and pinyon pines—representing a major change to a drier, more drought-tolerant ecosystem.

Or consider an area in Central Oregon called the Lost Forest. To all appearances, the forest looks healthy—a green tapestry of ponderosa pine spreading across five square miles of low buttes, ashy scablands, and rocky promontories. But the forest is barely hanging on. There are no other ponderosa pine for dozens of miles in any direction, and the region draws a scant nine inches of rain per year—significantly less than the amount usually necessary for pine.

The forest is a remnant from damper Ice Age climes, a leftover that has managed to perpetuate itself by shading the volcanic soils by just enough to allow that nine inches of rain to suffice not only for mature trees, but also for seedlings. But someday, probably not long in the future, the forest will be stretched beyond its ability to cope. Insects or fire will kill trees, the protective shade will disappear, and there will be no more seedling pines. In the blink of an ecological eye, the Lost Forest will be truly lost, replaced by the juniper and sagebrush that dominate the surrounding landscape.

When I researched this article, the American West was in the fourth year of a new drought. The forest fire season, which usually hits my home state of Oregon in late summer and early fall, had begun in earnest in July. In the Rockies, destructive crown fires have blazed through juniper forests that haven't burned so severely for at least 800 years. Just as the burned pines in New Mexico are being replaced by junipers, the burned junipers may also be replaced by something else.

Although it's easy to jump on the bandwagon and shout "global warming" with each drought or heat wave, the Earth indeed appears to be in the midst of ecological change more dramatic than anything since the K-T boundary. Some of the causes may be natural—the adjustments one would expect to see on a planet still rebounding from its latest Ice Age—but humans play a major role. Another mass extinction has begun, and it appears to be accelerating.

If there's a core question to be asked of paleoecology, it's this: what happens to the stability of ecosystems following such mass extinctions? And if we destabilize our ecosystems, what happens to us?

To date, the answers are uncertain. The Permian and K-T extinctions each were followed by explosions of new biodiversity—but not until the Earth's ecosystems had (metaphorically) licked their wounds for many years. One question is what human bioengineers might do to speed the recovery if we find that we've crippled our ecologies and des-

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perately need more diversity. Bringing extinct species back to life in the manner of *Jurassic Park* is a theme that's been widely explored in science fiction. But could even a recently extinct species be reintroduced, or would it merely go extinct again, a victim of the same forces that drove it to extinction in the first place?[15] A more interesting approach, one that's not been well explored by science fiction, would be for gene engineers to attempt to crank out new species to fill vacant niches—hopefully without creating plagues of superpests that would cause worse problems than they solve.

Another interesting science fictional question is what would have happened if the Earth had been hit by another asteroid shortly after the dinosaur-killer. Would most of the remaining species have died, or would those that couldn't handle it already have been culled by the first impact? An interesting prospect for science fiction world-building would be to work out the ecology of a planet that is hit by such rocks much more frequently than the Earth. If it bore life at all, would it be nothing but single-celled organisms? Or would its life have developed the ability to evolve rapidly after each impact, so that it could quickly adapt to climate changes?[16]

The good news from paleoecology is that the contemporary Earth may be more like this hypothetical planet than the relatively stable Earth that preceded the K-T and Permian extinctions. We've already noted that recent prehistory has seen some severe climate shifts. But if we look further back, we find some that are truly enormous. One of these was spotted in the 1970s in a Massachusetts bog, when researchers observed that 8,200 years ago there had been a sudden decline in hemlock pollen and a rise in beech pollen. At the time, the finding was a mystery. But in 2002, scientists realized that it represented a climate change in which the region suddenly turned colder and drier.

A few thousand years earlier, about 12,000 years ago, there was an even more dramatic climate shift, now called the Younger Dryas. (There's also an Older Dryas, which occurred several thousand years earlier). The Younger Dryas accompanied the end of the last Ice Age, and is named for a cold-climate flower (*Dryas*), whose pollen appeared virtually overnight in European bogs. It was an interlude in which far-northern temperatures dipped by up to 25°F over the course of about a decade and stayed low for more than 1,000 years. Then, the Younger Dryas ended nearly as quickly as it began, and the climate bounced promptly back to nearly pre-Dryas levels.[17]

I've discussed the causes of such climate shifts in a prior *Analog* article.[18] What matters now is their ecological effects, the most important of which is that the beech, hemlock, and Dryas did

[15] *Analog*'s own Stanley Schmidt examined this issue in his novelette, "Johnny Birdseed," printed in these pages in July 1993 and also available in *Generation Gap and Other Stories,* Five Star Publications, 2002.

[16] For one answer, see Wolf Read's story, "The Stones From Which Meadows Grow," *Analog*, March 1998.

[17] Richard B. Alley, *The Two-Mile Time Machine: Ice Cores, Abrupt Climate Change, and Our Future*, Princeton University Press, 2000.

[18] "Sedimentology Gone Wild," *supra*.

[19] As this article was going to press, the movie "The Day After Tomorrow" was making a hash of this entire line of research. But while the movie is preposterous, the evidence strongly shows that in the past, the Earth has undergone some extremely rapid climate shifts—just not quite as rapid as those depicted in the movie.

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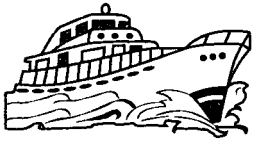
not go extinct. They simply shifted their ranges, very quickly, to take advantage of the sudden climate shift. Spruce trees, for example, declined in Canada's Maritime provinces but became more abundant in Massachusetts.

Ice core records from Greenland show that in the past few hundred thousand years, the Earth has gone through dozens of similar climate swings, many occurring fast enough to cause severe grief even to technologically sophisticated humans.[19] What this means is that today's ecosystems, unlike those of the Permian extinction and the K-T event, are already survivors of many climate shifts, some much more rapid than anything likely to result from human-caused global warming. When climate shifts, they are good at reseeding themselves into new environments and at surviving in refugia (such as Behrensmeyer's canopied forests).

This does not mean that human-induced climate change won't increasingly push species over the brink. Nor does it mean that ecosystems adapted to the rapid cooling cycles seen in the past will react equally well to today's unprecedented changes. "We live in interesting times," warns Jackson, "and they're going to get a lot more interesting very, very soon." But paleoecology *has* taught us that we live in a world that has seen its share of interesting times in the past.

About the Author: Richard A. Lovett is a frequent contributor of both fact articles and fiction. As an undergraduate, he majored in astrophysics, before shifting to law school, then getting a Ph.D. in economics. Had he discovered geology before finishing his formal education, he suspects that his career path might have been wildly different. As it is, he's a full-time writer and self-described geophysics junkie. He also writes books about bicycling, running, and cross-country skiing. ■



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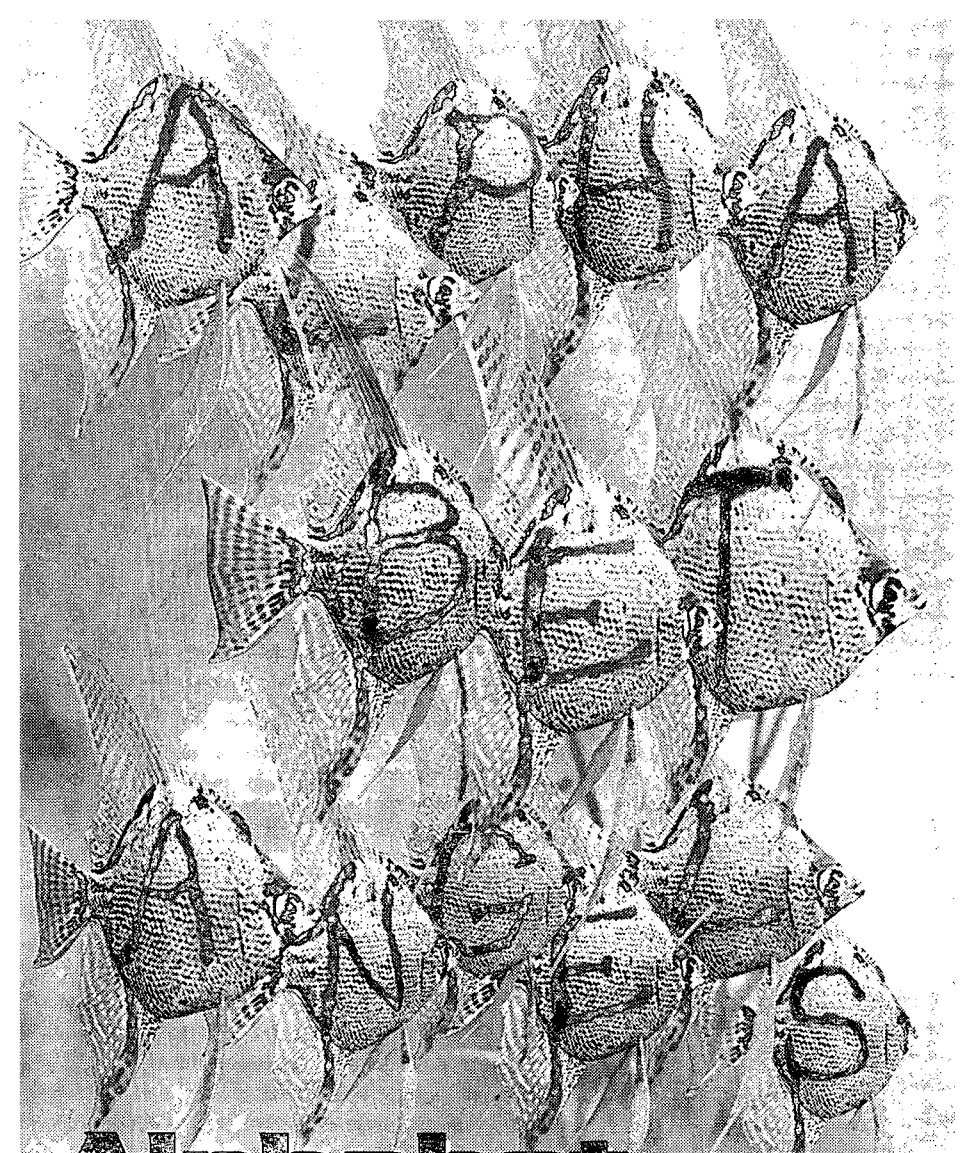

Alphabet Angels

Ekaterina Sedia and David Bartell

Illustration by Nicholas Jainschigg

Fundamental breakthroughs can be disconcerting—but fun!

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If Annabelle the fat-tailed gecko wasn't so fond of crickets, I would've never received a marriage proposal from a tank full of fish, and a new form of intelligence would have ended up pickled in a specimen jar.

I drive home, trying to forget about the new guy at work, not even thinking about Annabelle's crickets, when a miracle happens. I glance to my right and see a small handwritten sign that says in haphazard letters "PETS." Now, I know every pet store in a fifty-mile radius, and this one is news to me. This neighborhood is nearly a slum—rickety houses converted into shops that lean precariously. I've always ignored it before. The shop is probably one of those that only sell dog chew toys, bettas-in-the-vase, and water dishes anyway. Waste of time.

I do a U-turn. You know that you have no life when the highlight of your week is finding a new pet store.

I park on the gravel lot where I can read another cardboard sign in the window of the pet shop: "If you want a gerbil, go away." I giggle and go in.

It's dim except for the rippling light from the aquaria. Some fish are flitting about behind their walls of glass while others just lie there, and somehow the contrast in their behavior makes me feel melancholy. It's a dingy place. There will probably be more dead fish than live ones, and I'll bolt before anyone comes to help me. I look closer. The tanks themselves are all quite clean, and there's not a dead fish in sight. Just an eclectic and healthy collection of cichlids and labyrinthine fish.

"Can I help you?" A guy, pony-tailed, ear-pierced and thirtyish, looks down at me. He does not seem eager to help.

I glare instinctively—this one is probably no better than the new guy at work. First day on the job, and he could think of no better introduction than to come up very close behind the lab tech (me) and say, "You look like you work out."

"Yeah, fifteen years of martial arts," I said brightly.

The rest of the guys snickered, and John, our clinical researcher and boss, dragged the new guy away.

The new guy was hurt. "What the heck is wrong with her? She doesn't like men?"

"Jess doesn't like people," John said on my behalf.

Well, I don't actually dislike people—I'm just happier by myself. I didn't point this out to John because then someone would try to convince me that I'm not really happy by myself.

If the pet store clerk doesn't help me forget the incident, the selection of fish does. I'm staring and drooling, which is dangerous for me when I'm broke and there are fish for sale.

"Can I help you?" he says again, and shifts on his feet impatiently.

"They're beautiful," I breathe. "Where do you get them?"

"Breed my own," he says with quiet pride.

"Oh," I say, pretending not to be impressed. "And what have you got against gerbils?"

"Nothing," he says, looking down at me again. "I just don't carry them. I don't cater to children."

"Do you have crickets?" I ask, recalling the appetite of my rapacious gecko.

"Yeah, but they're not for sale." He watches my reaction with a sly smile. "I give them away with the purchase of any herp."

"What if I already have a herp?" I say.

He smiles some more. "You can always get another one." True, I think. Annabelle does seem awfully lonely lately.

"You buy from me, and it's a free lifetime supply of food," he tempts. The devil. Longhaired devil with no ass. He adds, "That even includes Hikari Betta Bio-Gold. You have Siamese fishes, don't you?"

"How did you know?"

He averts his eyes. "You seem like the

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type."

I actually don't mind this guy hitting on me—as long as it means free crickets. I also find myself thinking that he is kind of cute. "I could always use another betta," my mouth says. "And maybe a gecko."

We go to look at the bettas. Roundtails, crowntails, doubletails, halfmoons—I must've died and gone to heaven. I have enough will power to limit myself to two crowntails, and the guy puts them into plastic bags.

While he's doing that, I wander over to the lizards. I'm not disappointed—the cages are clean, and the selection is better than anything I've ever seen. Snakes, lizards, frogs, newts, and—oh my god, it cannot be—a tiger salamander. I look at the price tag. Damnation—sixty bucks. I can do without food for a week, right? Or take out a loan? Or move in with this guy. I look at him sideways, seriously evaluating his boyfriend potential.

"My name is Gus," he says as if on cue. "You want a ball python?"

"I already got one," I say. "His name's Paperweight."

Gus laughs. "Yeah," he says. "When they curl up all neat that's what they look like." He smiles, and looks into my eyes for the first time.

"You weren't supposed to get it," I say, and now it's me looking away. "No one does." I shake my head. This is all a dream—either that, or a disastrous spending spree in the making. Time to get out of here.

"Want to see my private stock?" he says. "It's in the back."

So that's it. "In the back?" I say, indignantly. "What, you're going to offer me a joint?"

Gus seems puzzled. "Don't have any pot, sorry," he says. "I just have some stock that I don't display here; the USDA might get upset."

I smirk, catching on. "I thought DEP was in charge of smuggled animals."

"Yeah, but mine were genetically engineered, and the USDA is the one that gets all worked up about that."

"Engineered?" I say, picturing mice with ears on their backs. "By whom?"

"Me." Gus demurs and looks into the floor. "They're pretty cool, if I may say so myself."

"You're a genetic engineer who runs a pet shop?" I ask, mentally pinching myself.

"Yeah," he says.

I don't wake up. I follow Gus between a giant newt tank and a chameleon cage to a door that has a biohazard sign, and 'KEEP OUT' written over it in grease pencil.

"I do have beer," Gus says, "but it's warm."

I nod, he pulls the tab, and Red Dog foams all over him.

I see two tanks in what was once a dining room. One is a fifty-gallon, and maybe a hundred sits behind it on a stainless-steel stand. I notice a camcorder on a tripod beside the tank.

I gasp as he goes to switch on a naked bulb that hangs on its cord, forlorn. In the smaller tank I see about a dozen small angelfish, their stripes shaped to form letters. I get it, they're fake, because they are arranged to spell out:

BATHING
HALF ASLEEP

"Watch this," he says, coming up behind the tank. He taps the glass.

They instantly shuffle and fan out to spell:

ALPHABET ANGELFISH

"Sweet Mary Mother of God," I say, and mean it. They're alive.

"Amen," he says, and means it.

"How do they do it?"

"I tweaked their pigment expression," he says. "Then I trained them to keep in line. You know, self-advertisement." He sighs. "I have way too much free time."

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I finish my beer in silence, and Gus, bless him, hands me another. "You like them?"

"Like them? They're amazing!"

"What's your name?" he says.

"Jessica?" I say, too shaken to think of something wittier.

He grabs a big plastic bag and fills it with water. I see that the larger tank has a hundred or so Alphabet Angels, and he deftly chases some with a net until the bag has a J, an E, two S's, I, C, and an A.

He hands me the bag, and says, "Seventy-five to eighty, neutral pH, tropical flakes. I wouldn't put anything else in with them."

"I won't," I promise, with a nod that's almost a curtsey. The devil. "How much are they?"

"It's a gift," he says. "I have to ask you to be discreet, though. Okay?"

"I understand. But I don't know if I can accept these." I'm lying. I wouldn't give them up for the world.

He shrugs. "Where else would you get personalized angels?"

As I turn to go, the smaller tank of ALPHABET ANGELFISH stirs in alarm. My bettas are staring fiercely at the alphabet school, and one flares his fins. The angels write:

HELP
A FLASHING BETA

"Cute," I say, but Gus is already out front. He hardly says another word as I leave with my bagful of alphabet fish, the two bettas, four dozen crickets, a salamander, and a lifetime mate for Annabelle. Hope she likes him. Hope Gus calls.

Three months after meeting Gus, I finish slathering the latest poison my boss John has brewed up onto Petri dishes with bacteria, and take off my lab coat.

"Someone's in a hurry," John sings, glistening the hundred-watt spotlight of his bald head at me. "Got a date?" The perennial lab joke.

"I don't date," I glower habitually. "Although there is a guy who'll be coming around later." I just can't help bragging about it.

"Pizza delivery?" Steve-the-not-so-new guy says. Some men just can't take rejection.

"Yeah," I say. "I prey on innocent greasy pizza boys—their blood tastes like garlic, and their—"

"All right!" John cracks up. "But seriously, who's the mystery man?"

"A pet shop owner," I say. "A man who wouldn't whore for the biomedical companies. A man who brings me crickets and beer instead of asinine flowers. I'll see you all Monday." I make my exit. "Oh, and my cats call him 'daddy'."

Sweet stunned silence.

I enter PETS, and see that he is cornered by a Japanese guy and his scrawny kid who are determined to buy some shubunkins. Gus grills them about pond volume, depth, filtration system, and proximity to trees. Buying stuff off Gus is painful; he does not like selling his stock. I have never seen a man so determined to fail in business.

I wander to the back and flip on the light. The ALPHABET ANGELFISH are watching and spell:

I SHAG
BEHALF PLANET

Out front the Japanese fellows have passed the test, and Gus looks like he's just sold his children into slavery. The deed is done, and the customers leave happy. Gus takes a new sign, a printed one that says 'No tobacco sales to anyone under 18.' He crosses out 'tobacco' and posts it. That's my Gussy.

"Do you really 'shag' on behalf of the entire planet?" I say, and he just laughs.

We head to my place, and I sigh, thinking that over the weekend he will have to rush out at least five times to check on his animals back home and at

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the store. Gus is apparently tired of it as well, for he says, "Jessie, would you like to consolidate the cats?"

I give him a level look. "Are you asking me to move in with you?"

He nods.

"Sure," I say. "Let's move to the store so that everything is at hand."

"Actually, there's a house for rent two blocks away from it, with a fireplace."

The devil. Somehow he knows that I would start imagining the two of us and the five cats seated around the fire, the room warm enough for the fighting fish, all forty of them lined up neatly on the bookshelves, the chirping of the crickets drifting in from the kitchen. Somehow he got me past the question of *whether* we should move in together directly to the one of *where*. The devil, the devil.

"We can check it out tomorrow," I say.

He nods again but seems preoccupied. "Jessie," he says, "have your fish been acting funny?"

"Which ones?"

"The angels."

"Well, the J had a ghastly accident with the disposal, and one of the S's swallowed a hook," I say, and hastily add, "Just kidding!" once I see his face. "They're fine. Why?"

He shrugs and waves his hand in dismissal.

We enter my apartment and both cats run up, mewling and rubbing against Gus. Both! Humph. Only Paperweight the snake is glad to see me. Gus opens a beer and starts making sandwiches. We're at that comfortable stage where food comes before groping. The phone rings.

I pick up. It's my mom. "I'm busy," I say into the phone.

"With what?" she asks suspiciously.

"I'm carving the names of Metallica members into my thigh," I say.

Gus snorts beer through his nose, coughs, and flips me off.

"Who's there?" asks Mom, who has hearing like a bat.

"Just the plumber," I say. "I lured him in under the guise of a leaking faucet, so he can impregnate me . . . All right, yes, I do have a boyfriend—sorry to have kept it from you. Well, I have to go now . . . he's all hopped up on goofballs and setting the kitchen on fire again."

"Can I talk to him?" She is seriously out of her mind.

I scowl into the phone. "Mom, you don't want to talk to a serial killer, do you?"

"Jessie," Mom says.

I sigh and thrust the receiver at Gus, who accepts reluctantly.

Mom chirps happily for a good five minutes, and Gus only says, "Mmmm," and "Uh-huh," and then, "Thirty-four. Rochester. No ma'am, never killed anyone. No, never been married either. NYU." He rolls his eyes at me. "I own a pet store."

I hear Mom's triumphant "A-ha!" Everyone seems to think that I'm using poor Gus for the sake of the bestiary. I feel genuinely hurt.

"Yes ma'am," Gus says. "Of course. I'd love to!" He hangs up and looks at me, dizzy. "I think we're having dinner with your parents next Sunday."

I give him a reassuring hug. "It's not too late to enter a suicide pact."

We munch on ham and cheese sandwiches. Gus still seems preoccupied.

"What's wrong?" I say. "My mom?"

"No." He sighs, his lovely brown eyes sadder than usual. "Mind if I check on your fish?"

"No," I say. "Although I resent the implication."

He smiles. "I just want to see them, and I swear that I have never doubted your ability to take care of them."

"All right then," I say, and follow him into the living room. The term is actually accurate—this is where everything lives. I do not have much furniture—just a futon, a coffee table, and a TV. The rest is bookshelves—some have books, the rest contain aquaria, terrariums, and any

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combination thereof.

Gus puts his beer on a coaster and makes a beeline for the alphabet angels. He taps the glass and watches them intently. "A-ha!" he screams, and points at the tank accusingly.

They have lined up facing the glass, and they spell out JESSICA.

"You see?" Gus seems agitated.

"So?" I say. "They do that all the time. I don't know when you trained them to do that, but-"

"I didn't," he says, and he's dead serious.

"But I thought—well, then, who did? It wasn't me."

"I know."

The fish break up and swim around more or less randomly. Then they line up again. The J is up front again, but it hovers upside-down, looking sort of like an 'n'. They spell:

nICE ASS

"Very funny," I say. "You had me going there."

"I didn't do it," he says in a shaky voice. Now he's creeping me out because I can tell he's not joking.

"Then what's going on?"

"Chaos theory, maybe," Gus says. "Did I ever tell you why I made them?"

"No."

"A friend was doing his PhD in some nonsense theory of chaos," he says, and sinks into the futon, his head clasped in his hands. "He was making a computer model of flocking birds, and he wanted to validate it. I told him that shoaling fish would be easier, since they are slower, and the environment is more controlled. You could even film them."

"Hence the video camera in your shop," I say.

"Yeah. Paul, my friend, said, 'How do you tell one fish apart from the other?' And I said—we've had a few drinks by then—'What if they're labeled with letters?' We drank some more, and kind of laughed about it—if we had fish like that they might start randomly spelling stuff."

"So you stumbled drunkenly to your secret lair and hooked up the generator to the lightning rod," I say.

Gus cringes. "I took some angels and just tweaked the pigment expression. It's pretty easy with fish—all the right genes are mapped; I just had to figure out what segments should express the color to approximate letters. I had some NSF funding anyway, and did the angels as a side project. Paul had defended by then, but I gave him a tank and a few sentences worth of these buggers as a graduation present. He got a kick out of it."

"And you kept some for yourself," I say. "Shame on you—what about the taxpayers' money?"

He grins weakly. "Paul called me two days ago. Said his fish started spelling stuff."

"Like what?" I say, and feel a chill.

"Like the weather," Gus says. "And they got it right."

I laugh, although I'm really creeped out. "Well," I say, "there's probably an explanation."

"Like what?"

"Maybe Paul had a newspaper nearby, or a TV on. They could have seen it and mimicked it."

"I suppose so," Gus says, "but there's more. I think I caught my angels spelling something also."

"What?" I ask.

He shakes his head. "Nothing that made any sense."

I tell him about the messages I've seen. He says he knows nothing about them. I'm dumbfounded, but then I can't recall him being nearby for anything other than ALPHABET ANGELFISH.

Gus is visibly disturbed by the nature of the messages. They resemble his own sense of humor altogether too much.

The phone rings again. "Mom forgot to ask what church you belong to," I say

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as I pick up the ringing beast. "What?" I growl.

"Jessica?" a pleasant male voice says.

"Yes," I say. "I love my existing long-distance provider and I've already found God."

The guy laughs. "My name's Paul," he says. "I'm a friend of Gus, and he said that I should look for him at this number. Is he there?"

"Sorry," I say. "Yeah, he's here."

Gus holds the receiver with his shoulder, his head tilted. "Really?" he says. "I'll be damned . . . No, nothing like that . . . Jessie's fish are doing it too . . . 'Jessica' and 'nice ass'." He gives me a sideways look. "Yeah, very much so. Okay, later." He hangs up.

"We should go to the store," Gus says. "You know, to see what the others have to say. The ones in the hundred-gallon."

I groan. "No. You're staying here, and so am I. I've got lots of beer and a Monty Python DVD."

Gus seems to lighten up. "You've been planning this, haven't you?"

"Damn it, Gus, I haven't had a boyfriend for who knows how long, so now I'm going to enjoy it."

The teenage mutant spelling fish can bloody well read themselves until Monday.

On Monday Gus drops me off at work.

"You want to come up?" I say. And explain, since he looks puzzled, "The guys I work with seem to think I'm making you up just to get out of rejecting them every Friday."

"Okay," Gus says. "Haven't been in a lab for quite a while. What exactly do you do in there?"

"Find cures for cancer," I say. "Except that they seem to be causing more cancer."

Gus laughs. "Gotta love research." He follows through the double doors, into the kingdom of laminated hoods and UV lights, PCR machines and smells of bacterial medium. He breathes in and smiles. Poor thing has been missing all this—it's written clearly on his sweet stubbly face.

I'm late, and the crew is in, drinking coffee and bullshitting.

"This is Gus," I say, and go to my bench. He can fend for himself in the butt-sniffing ritual.

"Hi, Gus," John says, his scalp wrinkled. "John Dorsey. How about that game last night?"

"Haven't seen it," Gus says. "Can't stand the Phillies. Hope they lost."

"Careful there," Steve says. "That's who we root for in our neck of the woods. What's your team?"

"Yankees," Gus says. "I cheered for them during the Red Sox game. In Boston. In an Irish pub."

I am vaguely aware of some sort of rivalry between New York and Boston in baseball terms, but the respectful silence that follows indicates that it is more serious than I thought.

"Wow," John says. I suppose Gus has proven his masculinity. "What were you doing in Boston?"

"Grad school," Gus says. "Wasn't that a nightmare."

John and Steve nod and mutter that oh God, was it though.

"Where at?" Steve asks. "I went to Boston U."

"MIT," Gus answers. "Probably before your time."

"What in?" John says.

"Genetics."

John perks up. "Human genome?"

"No," Gus says modestly. "Sommers' group."

Apparently, it actually means something, for John and Steve look at Gus as if he just confessed to being the seraph who hands God his pipe and slippers in the morning.

"I didn't think Sommers took grad students," John says.

"Not many, no. There was just me and Diane Thrench—she changed advisors halfway through. I don't blame her; Jim is a misogynist."

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The fact that he refers to fearsome Sommers by first name sends the guys gawking.

"You wouldn't happen to be," John says, "the G.S. Lanley of Lanley and Sommers 1998?"

"That's me," Gus says. "Which one did you read—the frog or the fish?"

"I read all of them," John says. "It is really amazing what you did with vertebrate development regulation."

"Thanks," Gus says. "Sommers' boys were all working with frogs, and I started the fish project. You know the frog DNA—nothing but repeats."

All of them sigh, appalled at the scandalous state of frog genes. I try not to giggle.

"Darn it," John says. "You have to give us a seminar, or something. Are you at U Penn?"

"I taught there for a bit," Gus says slowly, staring at a cluttered lab table. "It was a paper mill, so I quit."

"Where are you now?" John says, and smirks in my direction. "And don't say at a pet store."

Gus smiles. "I am, actually. I'd been breeding fish and frogs and herps for so long I figured I might as well turn it into a job. Which beckons." He turns to me. "I'll see you tonight?"

"Yeah," I say, and give him a kiss as a mark of ownership. It would be gauche to urinate all over him in public.

Later that day the phone rings, and John picks up. "Cancer lab," he says cheerfully. "Oh, hi, Gus." This is weird. Gus never calls me at work. "Yeah, I'd love to chat, Gus." John seems to like saying 'Gus' as much as I do. "Sure, whenever you want—heh, I thought it wouldn't be easy to quit. Of course we have a sequencer. Primers? Well, we do bacterial stuff, so I don't know about eukaryotes. If you can design them, I'll order them. No, don't worry about it, blanket accounts. What? Radioactive or fluorescent? Yeah, we have them. Stop by this afternoon and we can look at the primers. Don't mention it, Gus." He hangs up.

"Well?" I say.

John stares at me blankly. "Oh. Gus wanted to do a quickie analysis of one of his fish."

I think I know which one. I'm surprised to hear that he's willing to sacrifice them though. "You don't mind?" I say.

John gives me a condescending look. "Jess, that's *the* Lanley. If he kept at it, he would've had a Nobel Prize by now." He wags his finger at me. "You better be good to him."

Great. If Gus and I ever have a fight, I know not to ask John for sympathy. Around here, Gus walks on water. I'm a little jealous too, hearing how excited Gus was over all those toys. I'm not sure I can compete with an open account in a state-of-the-art lab.

The next morning, Gus drives his own 1987 Volvo station wagon to the lab, and immediately takes over like he owns the place. I am bossed around as it is, and the last thing I need is my own boyfriend saying things like, "Jessie, is there any Tris buffer left? I want to run some gels, and would you mind taking the dye out of the fridge for me?" in front of everybody.

John shadows him, and even Steve gets into a worshipful mood—he runs out and gets him a coffee. Humph. The rest of the week is no better: Gus is entrenched here, being brilliant, and only goes to his store for a couple of hours. I spend more time there than he does, just feeding the pets.

Rumors spread that *the* Lanley is working in the lab, and by Wednesday the curious start filing in. Most of them never heard of Gus, but take John's word for his celebrity status. Female interns and grad students are the worst—they ogle over Gus's shoulder as he is doing something as mundane as pouring a gel, and look like they're lining up for him to autograph their boobs. In the

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bathroom I find a whole herd of them, putting on makeup and talking.

"He's cute," Stephie from oncogenes is saying. "And single."

"Did he tell you that?" I say.

She shakes her head. "No ring, silly." Argh. Stephie gives me a condescending smile. "What do you care? You don't date."

Back in the lab, the freshened Stephie tries to engage Gus in a deep conversation about the loss of heterozygosity or some other such nonsense. Gus, bless him, is absorbed with pipetting his samples into the gel.

"Why don't you have the tech pipette the samples?" Stephie says, nodding at me.

Gus smiles in my direction. "I better not, or I'll hear about it when we get home. Isn't that so, my wild honey?"

Ah, vindication. "That's right," I say, trying not to gloat. "It's your turn to do the dishes," I add.

Stephie's jaw falls into her cleavage. I hope she bites herself.

Gus is quiet and contemplative as he drives me home.

"Gus," I say. "Did you find anything about the fish?"

"No," he says. "Their genes seem to be exactly the way I left them. Maybe if I amplify more fragments . . . There ve got to be more palindromes for the restriction analysis. I'll just have to order more endonucleases."

"I don't think it's the genes," I say. "Really, Gus—you're wasting your time, and the shop will be out of business by the time you snap out of it."

"Oh?" he says. "Since when are you an expert?"

Wham. "I'm not an expert," I say, indignant. "But if your cats could talk they'd tell you that obviously the fish are acting that way only in a school, not as individual organisms. The spelling thing is kind of an emergent property."

Gus frowns. "You don't like me being in your lab, is that it?"

"No," I say. "I love you being in the lab—I love you anywhere. I just think you're going in the wrong direction."

"Well, somehow I screwed up, and I have to go back to make sense of it."

I narrow my eyes. "You just love being in the lab again, don't you?"

"Not necessarily."

"I'll take that as a yes," I say. "Gus, please—stay in the shop tomorrow. Relax. Watch the fish. Harass the customers. I'll take a day off, and we can clean all the tanks. Please."

I watch his face, and my plea seems to be working—the angry fold between his eyebrows relaxes, and he even smiles a bit. "No," he says, scowling again. "You take a day off if you want—if you can let me work without breathing down my neck."

"Who was breathing down your neck? Me, or Stephie?"

"You know," he says with a snort, "I didn't like you putting me on the spot like that in front of everybody."

I can't believe this. "Oh really?" I say. "I seem to recall you defending me at the time."

"Of course, but I'd rather not have had to."

I'm at the point of no return. "So you'd rather they think you are available? Is that it?"

He shakes his head. "That's not what I said. It's just that I was trying to work."

"Gus, you're being a jerk," I say. "Drop me off at my place, and call if you decide to come to your senses."

"Fine," he says. He doesn't say another word until he stops in front of my apartment building. "Bye," he says, and takes off with unnecessary screeching.

I mope around the house for the entire Saturday without so much as speaking with Gus. The cats come and go and purr sympathetically, and the alphabet fish do drills. JESSICA, they recite at first. Then nICE ASS, though their heart isn't in it; they hardly stay in formation. Poor J is having trouble hovering upside-down. They look more like ICE ASS most of the

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time. As if in apology they do a new one, SEA SIC with J finally sitting it out altogether. I change their water, and they perk up a bit.

I feel guilty. Up to now, Gus and I have seen each other every day for months. I feel like calling him, crying into the phone and screaming that I love him. And it's not the other girls either: it's that damn lab. It's worse than baseball or NASCAR or the WWF or I don't know what. It's late afternoon, and I drive by the lab, but Gus's Volvo isn't there. I'll be damned if I'm going to go looking for him.

Okay, so I'll be damned. I drive by his place.

He's not there. I take it out on my car, and speed to PETS. He's not there either. It's closed. I let myself in with my key and tend to the animals. In the back of my mind I'm seeing car pile-ups on the freeway and dismembered bodies. I'm thinking James Dean. It just isn't like Gus to disappear for two days without a word.

I get a sinking feeling as I actually ponder what my mom would do if she hadn't heard from me for two days. God, I hate this, but I'm desperate.

I go home and start calling the hospitals. "We have no Gus Lanley here," they all say, from Philly to New York.

I call his house again. He's not there, so I leave a whimpering message. I stay up most of the night, but the bastard never calls back. I go to sleep at 3 AM, by which time the cats have reclaimed half of the bed. I dream of Gus in his car at the bottom of a dark river, with alphabet angels forming a living tombstone over his head:

GUS LANLEY
PATRON SAINT OF LOST ANGELS
AND WAYWARD GENES

Sunday morning I wake up to the ringing phone. Thank you, Lord.

"H'lo?" I say, swallowing the lump in my throat.

"Hi, Jessie," a male voice says. "It's Paul."

"Gus isn't here," I say gloomily.

"I know," Paul says. "He spent the night up here."

Thank God. "What's going on?"

"The boy wonder is at it again," Paul says, sympathetic. "Before he's done, we'll have fish with legs."

I laugh, and start warming up to this Paul guy. "Tell me about it. I told him that the spelling is an emergent property, and he's been incommunicado ever since."

"So that's it," he says. "I told him the exact same thing a while ago. He muttered something about a conspiracy. I've never seen him like this before."

I snivel. "Well, what is he doing up there? Where are you anyway?"

"New Brunswick. He didn't tell you he was coming?"

"No," I say, trying to exhale an Arctic wind through the phone.

"Sorry," Paul says. "I didn't know that. Honestly, he was just coming up to get my fish. I didn't want him to drive after all the scotch he sucked down. He should be home soon."

"I'm confused, Paul," I say, relief settling in. "What do you think is going on? The fish act like they know what they're doing."

"I know," he says, and he pauses. "Now don't freak out, but before Gus took my fish back, they were writing some pretty creepy things."

"Like what?" I say, preparing to freak out anyway.

"They moved from the weather to the news."

Now I'm too busy gasping for air to freak out. "You okay?" he says.

"Yeah," I exhale. "How would the fish know that?"

"I wouldn't say they *know* about anything. I do chaos, you know, and Gus has been mulling that around since this all started."

I think hard. "So it's not genetic. You're saying it's statistical."

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"I haven't a clue," he says. "But obviously the chaos theory doesn't explain all this." Paul keeps quiet for a while. "Think about it," he says finally. "How did they start spelling?"

"Gus trained them," I say, and sniff a bit, just at the sound of his name. "They like to mimic, and he just had these index cards with words written on them."

"Mmm. Suppose they started to form their own words."

"Wouldn't those be just gibberish? Don't they have to know English?"

"Not necessarily," Paul says. "Bear with me, I'm just thinking here. There are rules to any language. What if the fish internalized the rules and thus mastered the language?"

"Without understanding it?"

Paul huffs. "Why the hell not? Parrots do."

"But they don't make up their own sentences."

"Touché."

I think so hard my tears dry up. "And the fish do it as a group."

"Right, they act like a single organism."

"Like a beehive!" I scream, excited. "I think some vertebrates make colonies too."

"Pardon?" Paul says, and I remember that he's handicapped by his lack of biological training.

"You know, sea critters that form sort of a super-organism out of simple ones."

"Sponges?"

"Yeah, but they're invertebrates. I'm thinking of... what are they called?" For the first time in my life, I try to induce a flashback to vertebrate zoology class. "Chordate-something."

"Urochordata," Gus says, walking in. "Tunicates. Sea squirts. Is there any beer left?"

I leave the receiver dangling, and hug wayward Gus, as Paul is saying, "Hello? Are you there?"

Gus grabs the phone. "I'll call you back."

I'm too relieved to see him to be mad, but I scowl nonetheless. "You could've called."

"I know," Gus says. "I'm sorry for being an ass. I should have listened to you. Will you come to the store with me?"

"Sure," I say, surrendering any illusion of independence I might've harbored.

"John," I say into the phone the next morning. "I'm not going to be in today. Terrible night."

"Okay," John says. "Is Gus coming?"

"No!" I say in something worse than my usual pre-coffee grumble, and hang up.

Gus gives me an admiring look.

We spend Monday the same way we spent Sunday—watching the fish. Gus set up Paul's tank so that it faces the hundred-gallon. The fish in both tanks are active, rolling out sentences like a ticker tape. A net lies handy, for transfer of fish from one tank to the other. The camcorder is recording, and I feel like an explorer. "They're reinforcing each other's behavior," I say, and feel like Jane Goodall. Gus appears less thrilled. He's sitting on the floor, with a notepad on his bent knees, doodling and talking to himself. "No," he says. "This is just insane. I changed one gene—one gene—but what about the epistasis?"

"What?" I say.

He scowls. "Epistasis. Interactions of the genes... there are thousands of them. Perhaps by changing just one I changed the way it interacts with everything else."

"Oh. Hey, check this out," I say. "I think they're talking to each other!"

He lifts his head and watches the fish in his tank spell "REDUCTIONISM SUCKS".

Paul's fish reply, "NO TO DISSECTION".

"Great," Gus says bitterly. "They're making fun of me."

"They are right," I say. "The emergent properties cannot be studied by looking at their elements—like you can't under-

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stand time by taking a watch apart."

"I know, I know," he mumbles. "This is why we're looking at the whole damn school. And what did we learn? The more of them you put together, the smarter they get. Whoopee, what a surprise there."

"They seem to know what you're doing," I say. "And notice that they started with weather reports. They progressed from mimicking chaos—well, telling about it—to an ordered system." I turn towards the tank. "Hey, fish, do you understand what I'm saying?"

The fish consider, and just as Gus says, "You're out of your freaking mind, Jessie," both tanks flash in stereo: "OUT OF F WORD MIND".

"Jesus," I say. "They know what you're thinking!"

Gus groans and clasps his head in his hands. I'm surprised at how poorly he's taking it. You'd think a scientist would be excited to have created a brand new mind-reading form of life, but Gus only gets frustrated because he can't explain it away. It's not genetics, so he doesn't even know where to begin.

"Relax," I say. "We still don't really know how electrical impulses in the mind become words. No one says you have to know everything!"

He grumbles and doesn't deal. He doesn't deal well at all, and spends most of the day sitting on the floor with his head in his hands, refusing to look at the fish. And I can't leave them alone—these are the most entertaining things I have ever seen. They start doing an Abbot and Costello routine, and I crack up.

"How can you be so calm about it?" Gus explodes suddenly, looking at me like it's my fault.

I let it go for the moment. "Why not? Try to look at them as your personal I-Ching."

He snorts and shakes his head. "I don't know. I really screwed up, and I have no idea of how to make it right." He bolts to his feet and runs to the closet where he keeps all the nets, spare tubing, and other trappings. "Sod it," I hear him say.

"SOS," Gus's fish flash.

"SAVE OUR SOULS," Paul's fish clarify.

"Why?" I look around. "What's wrong?"

I find out when Gus reappears, holding a plastic gallon bottle. The cap is off, and I recognize the stench that makes my eyes water.

"What the hell are you doing?" I scream, blinking away the acrid tears.

"Stand back," Gus says. "I should've done this long ago." He raises the bottle and the fish fan out, panicking, spelling out the tag:

DANGER
FORMALIN
ACCIDENTAL INHALATION
MAY BE FATAL

I yank at the bottle. Gus is still holding onto it, but at least it's not anywhere near the fish. "Gus, you've lost your mind. It's not their fault."

He looks defeated. "I know. I don't want to, but if I start over..."

"Oh, honey," I say, and let go of the bottle.

Big mistake. Gus is still pulling on the handle and once I release the bottle, it goes flying and splashing into Gus's face. He inhales a lungful, gasps, and goes down.

It is late September, and finally starting to feel like fall. Light drizzle is tapping pleasantly on the window, and Buttons the cat pounces on me. Without Gus around, his cats have finally taken to me. I grab her and put her in the car. She's due for an annual checkup, and I'm going to stop by the vet on the way back. With no one to mind the store, I have to go daily and take care of the animals, but I never open shop. I decide against letting Buttons explore the shop on her own. She sees the fish and lizards, and puts on that "what, cute in-

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nocent me sink fangs into pretty little fish?" face. The fish are agitated, so I put her back in the car.

Inside, the angels are pretty chaotic. A few of them are writing, and I take a look because there are two rows repeating, which I've never seen before.

WAS IT A
WAS IT A

Then a C with the jitters finally swims into formation, but it still doesn't make sense.

WAS IT A
WAS IT A C

"No, it's BS," I answer. Finally the top line files down back to front as it joins the second.

WAS IT A CAT I SAW

Okay, yeah, it was a cat. I'm tempted to let Buttons have her way with the damn things.

I make the rounds and check back in on the angels before leaving. "JESSICA COME HERE," they say.

"I'm here," I say, amazed that they know my name. They break up and then reform the same message. "I'm here already!"

Over the next days JESSICA COME HERE becomes something of a refrain for them. No matter how I come and go, or sit patiently, they still ask for me. Then one morning I'm feeding the animals at home. My angels are dutifully spelling JESSICA, and it hits me.

I don't even call the lab. Instead I tie up my hair, bag the JESSICA fish and bring them to the shop. The other angels are very excited as I pour JESSICA in with them. I half expect them to spell out some kind of thanks, but instead they form another pattern I've never seen.

It's a message from Gus.

My tires machine-gun gravel into the curb as I speed from the parking lot to the main building of Kessler Hospital. I'm a regular, and the nurse on duty only nods to me, and goes back to her paperwork. I trip down the long hall and push the last door on the left.

To my great relief Gus is sitting up, and is finally off the ventilator. He wasn't much for conversation before that, not to mention making out between tokes of O_2. They should sell respirator masks as oral contraceptives.

"How's the store?" he asks. His eyebrows leap in sudden horror. "You didn't sell anything, did you?"

"No," I say, out of breath myself. "I just clean the cages and feed the snakes and things." I look at him sitting there, breathing, thinking. Gus keeps quiet, studying the pattern on his sheets as if he's seeing them for the first time in his life. The neat stripes are distorted by random wrinkles and folds. "You know," he finally says, "I've been wanting to ask you something, but I wanted to get this mask off first."

I laugh. "The cats are already consolidated," I say.

He makes a puzzled look and is about to speak, but I press a finger to his lips. "Before you propose marriage, I'd like you to promise that you'll never set your foot in any labs again. They are bad for you."

He pulls my hand away with encouraging strength. "Devil. How'd you guess?"

"Remember what I told you about your personal I-Ching?"

"More like Scrabble from Hell," he groans. "What exactly did they say?"

I grab a pen and some medical form from the table, turn the paper over, and draw:

JESSICA
O N
I GUS
N E
COLONY ■

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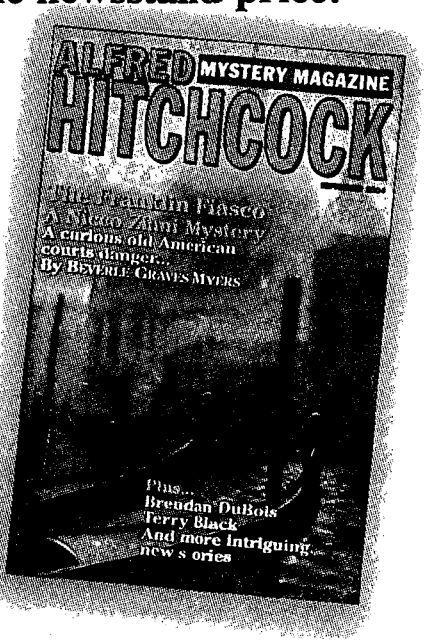

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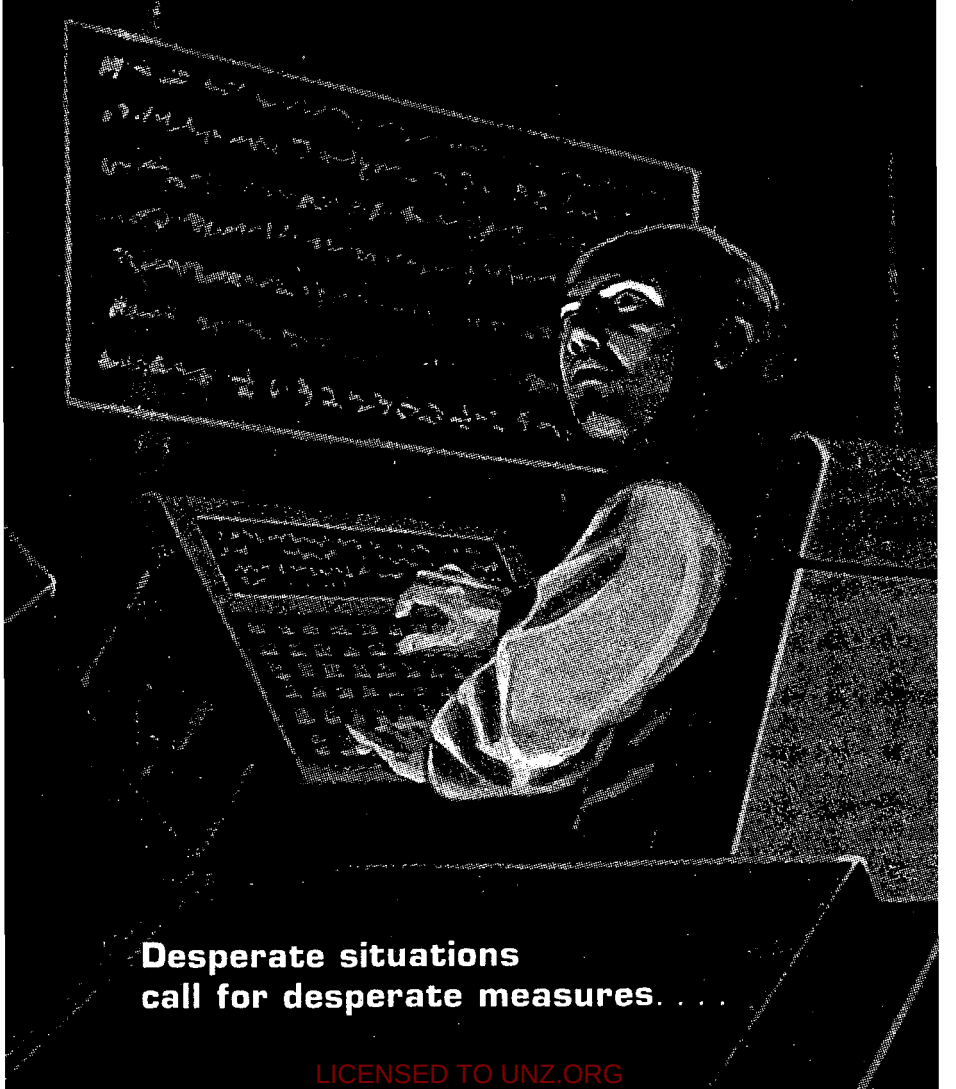
Dark Peril

James C. Glass

Illustration by Luis Perez



Desperate situations call for desperate measures. . . .

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Two ships went out, but only one returned, and there was both fear and relief among colonists and crew when the survivors told their stories. The idea of being mangled, then maybe spit into another universe, was just too terrible.

Captain Halver took most of the public heat for the affair, but privately it was the scientists people blamed. For the thousand souls onboard Cassandra I, the only mission was to get their great grandchildren safely to Eridani Blue, *not* to probe gravitational anomalies hidden within thick, molecular clouds. Three generations out from Aurigae and its crowds, Cassandra I led a flotilla of three worldships into the Orion arm of the galaxy, traveling nicely now at three-tenths c and scooping up enough reaction mass to last the remaining two generation lifetimes to Eridani. People weren't about to slow the ship for some harebrained mission dreamed up by a few.

The scientists, however, prevailed, arguing the mission would not slow the ship, and probe crew pickups could be arranged with Cassandra II or III following light days behind them. The research opportunity was unique, it seemed, and it was unlikely humanity would ever pass this way again.

Captain Halver agreed with them, and people muttered in dismay, for the probe ships were two of the eight shuttles designed to take them to the surface of Blue when they arrived.

Each probe had a crew of three. The crew members had all been up for five years since their latest twenty year cycle of frozen bliss. Pilots Anna and Yuri Pokorny left baby Katarina behind for the mission. Marines Lyn Kruger and Eric Brogan handled False Vacuum Communications and took a breather from what they thought was their secret romance. The scientists put Glade Adams and Sumio Tai on board for navigation and astronautics, but their real function was astrophysical modeling real time with what they observed. And in the end, it was Sumio who would make a place for himself in the history of Casandra I.

Anna was first out of the docking bay, Yuri only minutes behind her, and they flew in close formation towards the spot where the big gravitational anomaly had been detected. It was only a few light days out, but the mission was far shorter. Whatever it was, the thing was complex, maybe six or seven objects close together, four of them oscillating in a quadrupole way that seemed to be in response to a strong gravitational wave. And that's what interested the scientists the most. Black holes they'd seen before; now they had a cluster of them, oscillating in response to something unseen. All of this buried in a thick, molecular cloud fragment, but surrounded by an expanding shell that was likely a supernova shock front sweeping gas and dust along with it.

Once they neared the shock front, they should be able to distinguish the separate objects behind it and perhaps locate the source of the gravitational waves. Or so the mission profile said.

Cassandra I faded behind them, looking like a bug with a peanut-shaped body; antennae twice its length were the twin coils of the Warberg generator, sucking up exotic matter from the false vacuum of space and slowing the accelerated expansion of the universe by an amount too small to imagine.

"I have program lock," said Anna, and gestured with her right hand, following the retinal display. Beside her in the narrow compartment Eric yawned, and Sumio frantically gestured to power up the array of telescopes and sensors newly installed on what had been built as a landing craft.

"Got it," answered Yuri. "On your tail, darlin'."

Eric laughed. "Too close, and hubby'll be fried." He turned to Sumio, and tapped his shoulder. "Hey, slow down. We've got two or three standard days be-

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fore we get there. Slow and easy, man."

"Are you kidding?" said Sumio. "This is a flyby, and I'll have a few minutes to get everything at all wavelengths. Every sensor has to be 100 percent. There won't be a second chance at this."

Eric shook his head. "Bunch of black holes. We won't see anything we haven't seen before."

"Maybe," said Anna, and smiled. "Check the ship link, Eric, and keep it open. We might have to talk fast anytime. Our burn ends in thirty four seconds."

Eric complied, and there was a shudder at engine shutdown. "Visual coming up", announced Sumio. "Visible band only. I'll have IR up next."

Anna gestured in the air, watching the real-time trajectory profile as the picture of the outside world came up beside it. Blackness, no stars showing, only two wisps of red where hot, blue stars nestled in the unusually small molecular cloud. They were in it, now, as if traveling through an extraordinarily thin mist.

"On the wire," said Yuri. "Not much to see, but Glade has started a gamma intensity scan. We'll post it when we have something."

"Check," said Anna. "Enjoy the ride."

Four boring hours later the x-ray telescopes finally came up, and there was something to see, a roughly circular patch of glow ahead of them marking the shock bubble they were to penetrate. Brighter patches within the bubble were still too close to be resolved.

They were startled by a sudden engine burn of two seconds, the ship responding to gravitometer feedback to the program governing their trajectory, a hyperbola in and out of the shock bubble. Yuri called Anna, sounding concerned.

"A bit early for that, isn't it? We're still well over two days out from the target."

"Two seconds is a very small correction," said Anna. They were traveling at three tenths c, and any change in velocity would be out a few decimal places at the least. She didn't say that such an early burn had also surprised her.

When normal space microwave travel time delays exceeded thirty minutes, Eric turned on the small Warberg coil to access False Vacuum and instantaneous communication via the exotic matter flow back to Cassandra I. There were more surprises during the next several hours, four more burns, two of them less than a second. Anna was concerned enough to call Cassandra I. Captain Halver was sympathetic, but obviously had scientists hovering around him when he replied. "As you come in closer you're probably starting to resolve those masses in the shock bubble. The distribution affects the trajectory, Anna. It's a fine correction."

"Yes, but I don't recall us taking a bunch of auxiliary burns into consideration when we calculated the fuel requirements for the trajectory. All these little burns can add up," she said.

There was a short pause, then, "It's not seen as a problem here, Anna. Don't worry about it. We're watching."

Eric chuckled. "Oh, that makes me feel so much better."

Anna glared at him.

"He's right about one thing," said Sumio. "Those individual masses are resolving nicely. I think we can start orbital calculations. I see seven masses now, Glade. Can you handle that work? I want to stick with our trajectory updates."

"I'm on it," said Glade. Six voices on one channel between the two ships, though Eric and Lyn were occasionally switching to another channel to murmur private nothings to each other.

The False Vacuum line to Cassandra I remained open, and Halver continued his reassurance whenever there was a new burn reminding them of a finite fuel supply. Glade came back with his orbital calculation display, and the first visual of what the scientists thought were gravitational waves. A cursor moved, pointing out features. "Seven

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masses, at first look, but this one is resolving into two, a black hole with a dwarf companion. That explains why its the brightest of the bunch in the visible range. The other six are loners, and I estimate six to eight standard masses for each of them. This was probably a cluster of B-types formed together a few million years ago.

"They must have gone supernova with only short intervals between explosions. Seven closely spaced shock waves have literally blown a bubble inside this cloud, and even cleared out the supernova remnants we usually see."

"Is this new?" asked Anna.

"No. I've found records of similar results on systems of two or three black holes, but not from observations this close. Let me get this animation up, and I'll show you what's new."

They waited. "The motion is less than the resolution, to be honest, but the orbital modeling gives it consistently. Here it is," said Glade.

Seven objects, moving together on the retinal displays, a complex dance of colored balls in orbits about no obvious point, four of them oscillating back and forth from their orbital paths, in harmony. "The oscillations are highly exaggerated," said Glade. "They only show up on the doppler spectra. The actual vibration amplitudes are probably only meters for these masses. But that's pretty large. They're interacting with a powerful gravitational wave, all right, and that's why we're here, to find the source of that wave."

Erik shook his head, and muttered something into his microphone. Sumio frowned. "How sure are you about these orbits?"

"Not so good. I've extrapolated from only a few hours of measurements. Another few hours should get the periods down within 20 percent," said Glade. "But the orbits are probably open."

"Maybe," said Sumio. "At first glance, I'd say they're all moving around something big, somewhere around here." A cursor moved on the display, sweeping out a line. "That's roughly on the plane of our own orbit as we sweep past the system."

"There's nothing there," said Anna.

"Closest approach is way out from those masses, Sumio," said Glade.

"But we've been getting a lot of burns our orbital model didn't predict. That's coming from gravimetric measurements. There's a mass we're not seeing here, Glade. A big one."

Now Anna frowned. Her display showed only a few patches of light ahead of them on their present course. "In a few hours we'll be inside the bubble, and should be able to see a lot more than we can now. But if your simulations show something dangerous, I want to know it instantly. Understood?"

"Yes, Ma'am," said Glade and Sumio together.

"On your mark," said Yuri, and Anna silently thanked her husband for acknowledging her role as senior pilot on the mission. He was a quiet man, more devoted to his books than to flying, and a wonderful father to little Katarina. For this, Anna loved him dearly.

Sumio and Glade continued updating their simulations, and Anna filed another report with Captain Halver, who seemed optimistic as ever. The scientists on board Cassandra I were following the calculations on the big machine there, and talking with Sumio and Glade on a separate line. They talked, even dozed a little, and sucked a meal from plastic bottles, and were cleaning up after the meal when they penetrated the wall of the great bubble surrounding the cluster of dark masses and found themselves again in clear space.

No surprises were immediately visible. Six of the seven masses appeared as faint whorls of glowing gas, faint in the visible region, brighter in ultraviolet and x-ray. The seventh was a binary system, a bright tendril of gas being sucked from a deep red companion into a vortex with a black dot of a center. Sumio did

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an overlay in ultraviolet and x-ray, then added the twelve hours of gamma ray data he'd accumulated. Now something new was there, a faint spot near the center of the cluster, a thin band radiating from it in opposite directions. "Ah," said Sumio.

"Pretty faint," said Glade. "Barely above noise. Could be high energy, though. The detectors are only good to a hundred MeV."

"I still believe it," said Sumio. "The gas density here must be close to intergalactic levels. The other masses are a good indicator of that, and their spectra peak in the UV. This new thing could peak in the high gamma range. That would make it pretty heavy."

There was a pause. Anna looked at Sumio anxiously. "Is that why we're getting all these extra burns?"

Sumio nodded. "Could be," then, "Hey, Glade, how are those orbital periods coming?"

Another pause. Anna stared at her display, the faint flashes there as a pattern grew, reminding her of a spiral galaxy seen edge-on. *Something big there.* Her stomach trembled.

"Coming up," said Glade, and then a picture of balls moving in their orbits appeared, a mesmerizing dance around a central point, but none of the orbits were closed, all of them precessing in the same direction.

"No closed orbits?" Sumio scowled.

"I know. It's a mess. I don't know what's going on," said Glade. "The data sample is so small we shouldn't see anything like precessions."

"So it's really more like a simulation. Well, then, let's simulate the simulation. You know the masses of the objects, right? Use the gamma picture to locate a central force source, and vary the mass of that until you get the orbital mess we're seeing here. It could at least give us an idea of how big the invisible mass is. Look here." Sumio superimposed the weak gamma display on the orbital simulation. "See, it's not centered on those orbits. The orbits are probably highly eccentric ellipses. Regardless of mass, even relativistic effects could give a precession."

"Okay, I'll try it," said Glade, "but remember that the data sample is still small. The simulation could be way off to begin with, and—"

They were interrupted by a shudder as the engine ignited, and there was a hard burn that lasted seconds.

Anna gritted her teeth. "Whatever you do, try to find out what that missing mass is! On this trajectory, we're using too much fuel trying to stay away from it!"

"Yes, Ma'am," replied Glade.

"Eric, give me Captain Halver. Sumio, tell him what we have so far. I don't want to get any closer to this system than I have to." There was a hard edge in Anna's voice. Suddenly, she was a command pilot.

Halver was on the line in seconds. Sumio gave his report. They waited while Halver conferred with his scientists. When he came back, Anna was less than pleased with his answer.

"Stay on course, is the word here. We estimate 20 percent fuel reserve at end of mission. There's a lot of interest in that gamma ray picture you're getting. We might even ask you to go in closer than we'd planned."

"Begging your pardon, Captain, but we don't really know what's out there, or how big it is," said Anna. "It must be quite large to generate gamma rays, sir. I would like to shorten the mission profile, concentrate on getting a good gamma picture, and get us out of here. That is a request, sir."

There was a long pause. Eric smiled again, and shook his head. Sumio was oblivious to it all, plugged into the big machine on Casandra I and doing research.

"We see no need here for a change in profile just yet," said Halver. "You're a good pilot, Anna; that's why you're there. If there's an emergency, we'll rely

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on your instincts, but there's no emergency at the present time. Just stay the course. We're watching your fuel consumptions rate closely, and you're in no danger we can see."

"That's the problem," mumbled Eric, but Anna put a finger to her lips in warning.

"Is there a problem with communications, corporal?" asked Halver.

"No, sir," said Eric. He grinned, then shrugged. "The line is clear here."

"Keep it that way, and everything will be fine," said Halver, and broke the connection.

Eric looked sheepishly at Anna. "Sorry, Ma'am."

"Understood," she said, and squinted at her display. "If it helps, I agree with you. Just remember what the Captain said about relying on my instincts in an emergency. That way you can testify in my behalf at the Court Martial."

"Not funny, Anna," said Yuri. "Not funny at all."

"I didn't mean it to be," she said softly.

"I get a best fit for a value of a thousand standard masses, but it could be a hundred or a million. The orbits are so eccentric I can't get reliable values for the periods yet," said Glade.

"A hundred is more like it if this was once a blue star cluster," said Sumio. "If the central mass was really huge, I don't see how the cluster could have been stable long enough for the stars to go supernova. But that thing sure is putting out gamma rays."

"Lousy picture," said Glade.

"Yeah, but that band is showing up better. I wonder if we're looking at a disk, edge-on. I don't see any jets going off perpendicular to the disk, either. Probably not enough local dust and gas to make jets."

Anna squinted hard. "I see the band, but no central point that's brighter."

"Even a large black hole wouldn't be visible from here with so little gas present. We're still a light-day out from it," said Sumio. Something strange crawled in his stomach as he said it.

The engine fired again, a two second burn.

"Sixty percent reserve," said Anna.

And an hour later, Captain Halver called to say the profile was being changed to conserve fuel. The new orbit would take them closer to their target by half a light-day.

Anna's face turned bright red. "Is that really necessary, sir? It seems risky to rely on a slingshot effect with all these large, perturbing masses around."

"The calculations show a 2 percent fuel savings, Anna," said Halver, "but there's another reason for the change. Your gravitometer is showing oscillations we think might be gravitational waves. The big mass you're seeing in the gamma camera might be the source. We want you to get in closer so we can get an estimate of power versus distance. This is central to your mission, Anna, and the risk is minimal. We're not hanging you out on this one. And it's still your decision to change the profile if something unforeseen goes wrong."

Anna clenched her teeth. "I'll hold you to that, Captain—sir," she said.

"As long as you have a darn good reason for making a change," said Halver softly.

Yeah, but who decides how good is darn good? thought Anna.

In visible light, they were in a black void, a few wisps of glowing, red gas in tiny vortices above and below them, one red star with a tendril of gas reaching out to another vortex, and ahead of them—nothing. They were hours from closest approach, and the gamma camera showed nothing new, only a clearer picture of what they'd seen before, what seemed like a thin band of high energy photons that might intercept their course. Sumio had begun monitoring the gravitometer reception forwarded from Cassandra I, and seemed con-

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cerned. The wave intensity was increasing; the source was ahead of them, also emitting gamma rays. A disk-shaped object? An accretion disk? Making gravitational waves? No, not the disk, but something at its center.

A black hole. A big one. Spinning.

Something was still wrong. He called Glade, told him his new idea.

"A Kerr hole could give measurable waves, I suppose, but it would have to be huge, and spinning very fast," said Glade.

"I was thinking that, too. That would sure spread out the accretion disk, but shouldn't we still see a whole spectrum of light, and not just gammas? That band we see is entirely high energy. Something isn't fitting here."

There was a pause. "Yeah, I see what you mean. But if the hole is rapidly spinning, we could be looking at the innermost part of the accretion disk all spread out, and the rest is emitting too weakly to be seen."

It made sense, and for one moment Sumio felt he knew what was going on. "Okay, that's it, then. Another few hours, and we're out of here."

"Four hours to closest approach," said Glade. "Wave intensity is going up, but it sure doesn't look spherical. The source must be highly ellipsoidal."

"As expected, with a high spin. Take our pictures, and enjoy the ride," said Sumio, and believed it.

But that wasn't the way it happened.

Anna had listened to their conversation, less than assured they understood what they were heading for. She was a pilot, not an astrophysicist, and had instincts unrelated to equations, simulations, and neat mathematical models. Watching their trajectory, noting the increasing frequency of burns for the new mission profile, she felt something was missing in their environmental picture, a thing both hidden and sinister, a thing for which she must be ready. So her attention was rapt, even when Sumio and Glade had relaxed to do some personal research with the ship's vast computer. She even called Yuri.

"How far out do you want to be? I'd like to have you within fifty meters, please."

"Something wrong?" asked Yuri.

"No, just move in closer, so I can feel more motherly," she said, and Yuri complied, chuckling.

And an instinct told his wife they were safer than they had been a moment before.

She was only partially correct, for it was the private meanderings of Sumio in the ship's astronomical archives that would determine whether they lived or died during the next few hours.

An hour out from closest approach, they were all awake and alert when the ship suddenly vibrated violently with a low, resonating rumble. For one instant, the image of the black-hole-containing binary seemed to blur and drift, then was clear again as the vibration ceased as suddenly as it had begun.

"Yuri! We've just had a bad vibration here. Check our hull, please."

"We felt it, too," answered Yuri. "Checking—nothing to see. You're intact, Anna. It felt like our hull was rubbing up against something sticky. You okay?"

"Once I swallow my heart again," said Anna. She turned to Sumio, who was frowning in thought. Eric sat rigid, waiting for something more to happen. "A new phenomenon," she said, half joking. "What do you think, Sumio?"

"I don't know," he said, but his mind whirled, triggered by the vibration, putting together new pieces of what he'd been reading in the archives. "We're at least an hour out from closest approach, perhaps several light hours from the central mass, and the visibility is at best lousy. Even millions of standard masses would have an event horizon only tens of light seconds out, so we can't be anywhere near that."

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"Uh—Sumio," said Glade. "We've taken the central mass to be off center from the orbits of the other masses. We haven't actually measured it."

"We have two position coordinates from the gamma camera, but the third coordinate is iffy," said Sumio.

"That's it. You know, that could be why we're having so much trouble with the orbital simulation."

"Break it down for me, gentlemen," said Anna. "What does this all mean for us?"

Sumio swallowed hard. "It means that the event horizon for this big, black hole is nearly invisible, and we could be right on top of it, Ma'am." As he said it, another thought crawled in his mind.

"Sounds like a good reason for a long burn to get out of here, Mister," said Anna. "You certain about this?"

"No, Ma'am," said Sumio. "I wish I was."

"Then we stick with it. Eric, get Halver on the line."

Anna reported to her Captain in a calm voice, giving him every detail of the incident and the conjectures of her navigators. Halver went to confer with his scientists, forcing her to wait for an answer, and they were now only minutes from closest approach. Outside the ship there was only a thin band of high energy radiation to be seen, yet Sumio knew a great mass was there, perhaps hours, even seconds away. How could something big be so invisible?

The answer came to him just as the vibrations began again, this time softer, but more sustained. Sumio looked at his display. The image of the black-hole binary was there again, only it wasn't one image, but several, and all were suddenly moving.

And Sumio knew. "We've got to get out of here, and fast!" he shouted. "That's not a black hole out there; it's a naked singularity, and we're skipping along the edge of its ergosphere!"

Anna's eyes got very large. "What?"

"A rapidly spinning black hole, spinning so fast it doesn't have an event horizon but an ergosphere, a region around it where spacetime spins with it. We're right at the outer edge of it. If we drop inside, there's only one way to get out, and that's all theory, and anyway, naked singularities aren't even supposed to exist, and—"

"Stop it!" shouted Anna. "This is not telling me what do!"

"I recommend we get the hell out of here, Ma'am," said Eric.

"We're near maximum velocity at closest approach. It'll take a long burn now to change our orbit appreciably. A really long burn," growled Anna.

The vibrations were increasing. For an instant, Anna seemed frozen. Sumio was thinking furiously; the theory was unproven, and there was no time for calculations. They had minutes, at best, to make their move.

Halver was suddenly back to them. Anna's teeth were rattling as she screamed at him, "We're being shaken to pieces here. I have to abort the mission! Sumio, tell him what you think!"

Sumio told him, and there was disbelief. Naked singularities had been proven to be unstable, at best, years before, and probably did not exist. The concept of an ergosphere was thus nonsense. A twelve second burn would put them on a substantially safer trajectory and leave them with a 2 percent reserve.

That was the order given to Anna.

Two minutes later, she made the burn.

The vibrations did not cease, and the change in their trajectory was found to be negligible.

Ergosphere or not, they were now falling into an orbit around a great, unseen mass, with insufficient fuel to make an escape. Even Halver acknowledged that, and apologized for his assessment of the situation. "Sit tight," he said. "We'll work something out here." And then he left them.

Anna was strangely calm. She called Yuri, and they discussed who might care

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for little Katarina when they were gone. Eric mumbled quietly in his mike, undoubtedly to Lyn in her ship only meters away. Sumio made his calculations as fast as he could until Halver came back on line to tell them the scientists were still working on the problem.

The ship vibrations were continuous now. Likely they would slowly descend in a spiral orbit until they reached the singularity and oblivion, but here, near the top of the ergosphere, there was still a chance. When Halver switched off, and Anna was still chuckling at his stupidity, Sumio made his move.

"Ma'am? If you'll trust me, I can get us out of here."

Anna shook her head. "If you can do it with a fifteen second burn, I'll believe you. That's all we have left."

"If I'm right, Ma'am, we won't need all of it. The spin energy we pick up from this spinning singularity will be enough to kick us out hard. I just hope it doesn't tear us apart in the process. But we have to lose one of the ships."

"Oh, that's good news," growled Eric in disgust, and Anna raised an eyebrow. Sumio's faced flushed.

"Look, you have other options, just jump right in. My idea is based on an untested theory, all right, but the conditions are correct. For a brief instant we were spinning with the ergosphere, and you could see the relative motion of the neighboring black holes out there. From those motions, the ergosphere spin is opposite to our initial trajectory. In the archives, there's a theory by a guy named Penrose. You shoot a particle into an ergosphere, opposite to the spin direction. You fragment the particle; one piece is captured by the naked singularity nearby, the other piece is kicked out using a part of the singularity's spin energy. That's a lot of energy, it turns out. I've done a rough calculation. It won't put us back on our original trajectory, but it's close enough for us to be eventually picked up."

Eric laughed. "We're the particle. We blow up the ship, and part of it escapes. Come on, Sumio. Let's call someone to come in here and pick us up."

"Not enough time," said Anna. "What is the particle, Sumio? You said we'd have to lose a ship."

"We have to dock," said Sumio, "and all of us get into one ship. The main burn is against the flow of the ergosphere, but there's a shorter secondary burn for the empty ship, and then we blow the connector bolts for separation. The calculation is rough, Ma'am, but I'm sure it's good enough to get us out of here."

"This is crazy," said Eric.

"Yes, it is," said Anna, "but I do know a little physics. If that mass out there is as big as I think it is, we don't need to borrow much energy from it to get out of here. And we need to do something *now*!"

The ship suddenly lurched, as if in response to what she'd said. Anna called Yuri; they talked for only a minute, Yuri putting all in her hands. Anna said she'd be right back to him, then had Eric put in a connection to Captain Halver.

"Nothing new, Anna," said Halver. "We're working on it."

Anna grimaced her disgust. "No time anyway, Captain. We're going to try something here. If I'm not back to you within half an hour, then we're probably all dead."

"Don't do anything without our—" Halver began, and Anna cut him off. She turned to Eric. "No communications unless we survive this," she said coldly.

"Yes, Ma'am"," said Eric, and glared at Sumio. *This crazy idea of yours is going to get us killed*, he seemed to say.

But Anna was operating in action mode. She ordered Yuri to dock with her ship, a simple task in normal space, and they were only meters apart at the moment. But the entire operation took nearly half an hour; they were moving in and out of a spinning reference frame, and Yuri was fighting new Coriolis forces all the way. The only real progress

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was during the brief seconds when they were just above the edge of the ergosphere and again in normal space. Sumio held his breath a lot during docking, and kept his secret to himself: once they were completely buried in the ergosphere, there would be no docking possible, and they would all die.

He let out his breath in a whoosh when he heard the metallic clang of the docking ports locking together.

Yuri, Lyn and Glade came forward to the cockpit for brief, quietly emotional greetings before heading aft to strap themselves down in the yawning passenger bay designed for a hundred people. The way Lyn looked at Eric made Sumio envy the man for the first time. Anna and Yuri had merely touched foreheads, and closed their eyes.

Sumio loaded the new profile into the computer. It was a gimbaled burn, two seconds for a dip into the ergosphere, followed by five seconds against the flow, a two second burn by the empty ship just before locking bolts exploded for separation.

He was still surprised his idea had even been accepted by the others. But there were no other options. Only a slow spiral into a crushing depth. Outside, the phantom of an object said to be impossible glowed weakly in high energy gamma emission. If only he'd had detectors that could see far, far into the gamma range. A band, but not a band, really. A rapidly spinning core of quarks, strings, flattened out into a disk with a slight bulge at the center; this was the likely picture. How far out were they? Minutes? Nearly close enough to touch the very beginning of everything.

"Anything I need to do?" asked Anna, pulling hard on her shoulder harness.

"No, Ma'am, except hang on. My hope is we'll leave the ergosphere tangentially, but as we dip into it things could be rough. There will be a brief period of acceleration as we hit normal space. A short spike, real high, like a batted ball, I think. Strap in tight, Ma'am."

Anna gave everyone a few minutes to strap in tight, then turned to Sumio and sighed in a resigned sort of way that made Sumio's face flush again. "Okay," she said, "let's get this over with."

Sumio was strapped in so tight he had to stretch his index finger to move the cursor on his display. He started the countdown at twenty seconds, checking the status of both ships' engines. At ten seconds he punched in 'EXECUTE', then pressed his head back into his seat and closed his eyes.

The sudden bump, and sound of the engine burn was familiar, but the entire cockpit began to vibrate wildly around him. He felt a strange disorientation, then a thud, then it was as if he was slammed face first into a wall and held there in a suffocating stranglehold. He blacked out, but only for a moment. When he opened his eyes, his display showed a black void with the distant glow of hot, blue stars, and Halver was screaming into his ear.

"Anna! *Anna!* What the hell is going on out there?"

They didn't get picked up for seven days.

The ergosphere had spit them out into a trajectory that nearly took them back to Cassandra I, but fell short, so they had to wait two days for Cassandra II. Their ship, fuel spent, was towed back by another shuttle and found to be intact, amazingly enough. There had been some interior damage from loose items flying around during acceleration, things like a writing stylus sticking into a steel wall. Tough instrument, and tougher people. Accelerometers on board went up to fifteen g's, and had gone off scale during the escape. Everyone had aches here and there, bruised shoulders and ribs, nothing serious, physically.

Mental problems hung on a while: a sense of detachment from the ship's busy world, short concentration spans, a kind of waking-dream-state that per-

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sisted even after a debriefing and then a formal reception with fine food and drink. People were thrilled by their adventure, and wanted to hear all about it. Anna and Yuri leaned warmly against each other, and said a few things. Eric and Lyn held hands, and said nothing. Anna graciously praised Sumio for solving the problem that had threatened their lives, but Sumio quietly left the room before she thought of proposing a toast to him.

Glade was sent to fetch him, found Sumio in the forward lounge, relaxed in a deep chair and staring up at the viewing screen for the outside panoramic camera. Glade pulled up a chair, placed a bottle and two glasses down on the low table in front of them.

"I'm supposed to drag you back to the party," said Glade, and he filled the two glasses with bubbly wine. "Anna wants to toast your brilliance."

"It was both of us, Glade," said Sumio.

"Not really, but thanks anyway," said Glade. He offered a glass to Sumio, looked up at the screen. "From here, it looks really black, that little cloud. You'd never guess what's inside it. That cloud is doomed."

"We didn't even see it," said Sumio softly, "and we were so close it nearly killed us. A doorway to another universe, Glade, and we didn't see it."

"Pretty small door," said Glade. "A core a meter across, tops. We were not a good fit."

Sumio took a sip of wine. His eyes suddenly brightened. "If we come back with really big detectors that can go well into the TeV range, I bet we can see it."

Glade shook his head, grinned, and raised his glass. "To human curiosity," he said.

"I'd rather drink to Penrose," said Sumio, and laughed.

Their glasses clinked together. ■

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COPERNICAN PRINCIPLE

Robert Scherrer

Professor John Rapaport paced back and forth at the front of his Astronomy 111 class, waving a sheaf of papers in the air. "Class," he said, "your performance on the midterm exam was abysmal. Let me correct a few of your misconceptions: Venus is *not* a star. The Sun *is* a star. And Pluto is *not*, repeat *not* 'Mickey's dog.'"

John dropped the exams on the lectern and surveyed the faces of his yawning students. Mike McNamara snored in the last row, his enormous forearms folded on the desk, his crew-cut head resting on his arms. Mike had been the football team's star linebacker until that unfortunate incident involving the Chevy dealer.

"Mike, wake up!"

Mike's head shot up. "Yes, Professor Rapaport?"

"Mike, today we're going to discuss the Copernican Principle." John picked up a green marker and wrote "COPERNICAN PRINCIPLE" on the whiteboard. "What is the Copernican Principle?"

Mike stared, his eyes wide and his mouth gaping—a moose caught in the headlights. "Uh, I don't remember."

"Did anyone do the assigned reading?" asked John. "Paul, please tell me that you did the reading."

Paul Kresge put down his newspaper, revealing a face covered with metal studs—pierced ears, pierced nose, pierced lips. Did the man set off airport metal detectors? But at least Paul thought for himself—he was the only one in class who ever challenged anything John said.

"No," said Paul. "I thought this week's reading was boring. I read Chapter 17 instead."

"Not too smart, Paul," said John. "Okay, class, I'll just tell you what the Copernican Principle says. Copernicus showed that the Earth is not the center of the Universe. The Copernican Principle says that we don't occupy *any* special place in the Universe." John sketched a green spiral on the whiteboard and marked an X near the edge. "For example, the Sun is not located at the center of the Galaxy. It occupies an unremarkable location about two-thirds of the way out from the center."

"Wait a minute," said Paul. "Last week you told us that our galaxy is larger than average. Doesn't the Copernican Principle mean we should live in an average-

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sized galaxy?"

John smiled. "Now you're thinking, Paul. The Copernican Principle says that the Earth should orbit an average *star*. We're just as likely to orbit one star as any other—"

"—and the bigger galaxies have more stars," interrupted Paul, "so we're more likely to find ourselves living in a big galaxy."

"Exactly!" said John. "Can anyone think of another application of the Copernican principle?"

An awkward silence filled the room, broken only by the faint ticking of the wall clock above the whiteboard. Paul raised his hand. "I've got one for you," he said. "I just read about this guy in England who claims that any advanced civilization will make computer simulations that are just like real life. So if every civilization made a million of these simulations, then the Copernican Principle says that we're more likely to be living inside a computer than in the real world."

"Well, Paul, you shouldn't push these arguments too far."

"And what's wrong with my argument?" asked Paul.

"Well, it's just that . . ." John scratched his head. "Let me think about it—I'll tell you tomorrow."

Walt Gustafson slurped a strand of egg noodles in the Chinese dive on High Street where he always met John for lunch on Wednesdays. "That's the problem with theoretical types like you," said Walt, pointing a chopstick at John. "An engineer like me is never going to start believing this kind of nonsense."

"But how can you prove it?" asked John.

Walt tried to pry open a plastic pouch of hot Chinese mustard with his fingers, gave up, and slit it with a knife. "Well, for one thing," said Walt, "if we lived in a computer simulation, these mustard pouches would be a lot easier to open."

"Be serious," said John. "I think the kid's argument is basically right—the Copernican Principle says we're more likely to be living in a computer simulation than not."

Walt shrugged. "Theories should follow reality, not the other way around." He cracked open his fortune cookie and pulled out the slip of paper from inside. "Hey, look at this," he said. "It says, 'The system will be shutting down in five minutes. Please save your work.'"

"What!" said John. He lunged across the table and tried to grab the fortune, but Walt pulled it away from his grasp.

"Sheesh," said Walt. "I'm just kidding." He popped the fortune cookie into his mouth. "You're really wound up about this."

"Well, what if they did shut us down?"

"Let me put your mind at ease," said Walt. He slapped the table, rattling the dishes and knocking over a plastic cup. "There, does that sound like a computer simulation to you? Ouch, it hurt, too. That's reality."

"Or it could just be a very convincing simulation of reality," said John.

"Oh, it's going to be hard to convince you, isn't it? I'll tell you what—suppose I can come up with an argument from the Copernican Principle that's so completely absurd that it shows that the whole idea is preposterous. Will you give up and stop worrying then?"

"Like what?" asked John.

Walt leaned back in his chair. "Try this one," he said. "Any advanced civilization is going to produce an enormous number of works of fiction. So the Copernican Principle says that we're actually more likely to be fictional characters than real people. Now you have to admit that *that's* ridiculous."

John was silent for a moment and then chuckled. "That's a good one, Walt."

Walt laughed. "And the funniest thing is that when the story ended, we would just disappear—poof! Now stop worrying and please pass the—"■

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The Big Rip at the End of Time

This column is about the end of the universe and of time itself, as implied by a new variant of the standard model of Big Bang cosmology. But before considering the destruction of the universe-as-we-know-it, we will need to review the most startling development in modern cosmology: the discovery that the expansion of the universe is increasing due to "dark energy" contained in space itself. The best evidence for dark energy comes from studies of Type Ia supernovas.

A Type Ia supernova is a burned-out star that is in a binary orbit around another star, from which it receives a flow of hydrogen gas that builds up on its surface. After enough hydrogen has accumulated, it suddenly detonates in a thermonuclear fusion explosion. The detonating star shines with extraordinary brilliance, brighter than the rest of the galaxy, for a period of up to a month and then fades away. Such supernovas occur in all galaxies and can be observed (during their period of brilliance) in our galactic neighbors and also in galaxies half way across the universe. Since the brightness of a supernova a distance (r) away will be diminished by $1/r^2$, a measurement of light intensity gives information about distance. However, a plot of the red shifts of nearby supernovas against the distances inferred from observed brightness shows considerable scatter around average straight-line behavior. This demonstrates that Type Ia supernovas are *not* all of identical brightness, and therefore that supernova brightness cannot be used directly as a distance indicator.

However, two groups, one led by Australian astronomer Brian P. Schmidt and the other by Saul Perlmutter of the Lawrence Berkeley Laboratory, found a cure for this problem. They tracked the "light curve," the intensity vs. time of nearby Type Ia supernovas as observed through blue and violet filters, and found significant differences in falloff times of the light from one object to another, from falloff in about 10 days to over 30 days. They used these light-curve differences to generate a correction that brought nearby Type Ia supernovas of the same red-shift to the same intensity. When they plotted red-shift against distance using the corrected intensities, the scatter was gone and all of the Type Ia supernovas fell nicely on the same straight-line curve, demonstrating their value in establishing an astronomical distance scale.

The groups then extended the plot to more distant supernovas, where the plot was expected to fall below straight line behavior because of the expansion rate of the universe was expected to slow due to the pull of gravity, modifying the red-shift. But instead of the distant supernova points falling below the expected straight-line, the points were elevated *above* the straight line. Conclusion: the expansion rate of the universe is not decreasing with time, it is *increasing*

But how could the expansion of the universe be accelerating? It turns out that Albert Einstein's general theory of

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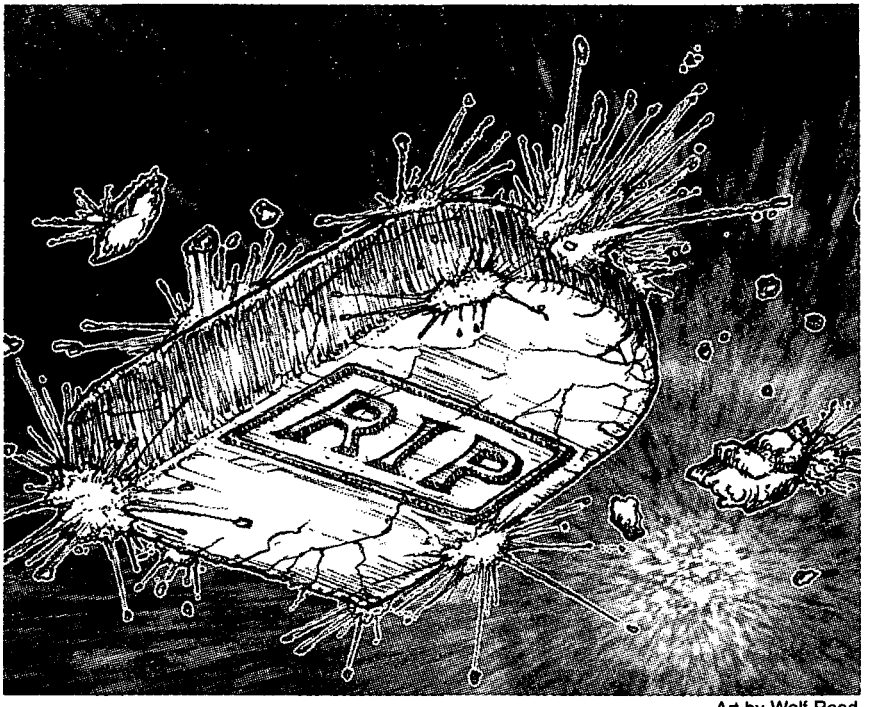

Art by Wolf Read

relativity, our present standard model for gravity, contains a built-in answer to this question. Einstein, in order to accommodate model universes that did not collapse on themselves under the pull of gravity, included the possibility that the empty vacuum itself might have an intrinsic mass-energy, which we now refer to as "dark energy." He added to his equations a term Λ (Greek capital Lambda) which he called "the cosmological constant." Einstein's cosmological constant Λ puts dark energy in the vacuum itself.

In universes described by general relativity, adding mass-energy to the vacuum has a different effect from adding mass-energy in the form of matter. Dark energy, in addition to the expected gravitational attraction, also produces a negative pressure that is three times bigger than the gravitational attraction and acts in the opposite (antigravity) direction. The repulsive force associated with dark energy grows linearly with distance, becoming very strong between objects separated by large distances and balancing or overcoming the tendency of universes to collapse due to the pull of gravity. The groups measuring the accelerated expansion of the universe have concluded that 70% of the total mass-energy of the universe is in the form of dark energy.

The unresolved issue is whether the repulsion of dark energy is constant, growing, or shrinking with time. Einstein assumed that his cosmological constant Λ was truly constant with time. That implies that any unit volume of space contains the same fixed amount of dark energy ($\rho_\Lambda \approx 6.7 \times 10^{-10}$ joules per cubic meter). An alternative called "quintessence" suggests that the density of dark energy is produced by a primordial scalar field that permeates the universe and depends on the size of the universe, so that the dark energy density ρ_Λ

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was larger in the early universe and will become smaller as the universe continues to expand and evolve. All such cosmologies can be described by assuming that ρ_Λ is proportional to $a(t)^{-3(1+w)}$, where a(t) is the time-dependent scale-factor (i.e., radius) of the universe and w is the so-called "equation-of-state" parameter.

The parameter w is not well determined by observational data. It should be exactly -1 for Einstein's unchanging cosmological constant. It could be anywhere between -1/3 and -1 for quintessence models. Combined observational data from type Ia supernovas, galactic cluster abundances, gravitational lensing, and the apparent age of the universe favor a value of w that is more negative than about -0.8, tending to support Einstein's assumption of a constant time-independent ρ_Λ.

However, a recent paper written by Robert P. Caldwell of Dartmouth College and Marc Kamionkowski and Nevin Weinberg of Cal Tech has raised the question of whether w can be *more* negative than -1.0. This concept has been called "phantom energy" because an expanding universe with w less than -1would have a rapidly increasing net energy. In the phantom energy scenario, ρ_Λ, the dark energy content of a cubic meter of vacuum, increases with time as the universe expands. The observational data showing that w is less than -0.8 can also be interpreted as allowing negative w values as negative as about -1.5.

If w is less than -1, the energy density ρ_Λ increases as the universe expands. The growing energy density increases the negative pressure, driving the acceleration of the expansion harder, leading to more volume and more energy, etc. This produces a "runaway" feedback loop that makes the universe expand explosively. The accelerated expansion of the universe itself accelerates and reaches an "end of time" limit that the authors call t_{rip}. Assuming w = -1.5, available data would put is value at about t_{rip} = 22 billion years from now.

About a billion years before t_{rip}, the growing negative pressure will rip apart galactic clusters. At 60 million years before t_{rip} the Milky Way galaxy will be dispersed. At about three months before t_{rip} the gravitational pull of the Sun is countered by negative pressure and the Solar System disperses, first the outer planets and then the inner planets. At 30 minutes before t_{rip} negative pressure explodes the Earth. At 10^{-19} seconds before t_{rip} the negative pressure dissociates all atoms. A short time later the negative pressure dissociates nuclei into neutrons and protons.

What the negative pressure does at the quark level is an interesting question, because the color force should grow as neutrons and protons are pulled apart into their constituent up and down quarks. The authors say that at this point they expect some new physics, in the form of spontaneous particle production or extra-dimensional effects or string or quantum-gravity effects to kick in. In any case, time has effectively ended. The resulting universe has no structure, and all point-like particles—electrons, neutrinos, and quarks—are isolated as the only particle in their event horizon, with all other particles receding at superluminal velocities. The implication is that the universe may not end with a bang or a whimper or by fire or by ice or with a Big Crunch, but by a ripping apart of all structure. How likely is this picture of the ultimate fate of the universe? As I said above, present observational data (which will improve in the next few years) tells us that w is roughly between -0.8 and -1.5 or so, allowing plenty of room for a Big Rip scenario.

However, the phantom energy scenario does violate a cherished tenet of general relativity called "the dominant energy condition," a principle that keeps energies positive and imposes energy conservation on a global scale. It is the dominant energy condition that

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helps to rule out some manipulations of general relativity that would permit things like wormholes, warp drives, and time machines. If the phantom energy scenario has any validity, the dominant energy condition can only be satisfied by broadening the picture, so that the phantom energy would have to be supplied from some phantom source "outside" the universe. The present work assuming w< -1 cosmologies does not address this issue.

What are the science fictional implications of the Big Rip and phantom energy cosmology? There would seem to be no immediate consequences, in that the entire evolution of the universe so far has taken us only about 1/3 of the way from the Big Bang to the Big Rip. The rate of growth of the energy present in the vacuum, presently about $6.7 \cdot 10^{-10}$ joules of dark energy in each cubic meter of vacuum, is not large enough to represent any significant source of energy for SF applications like spaceship drives. Therefore, the implications of the scenario apply mainly to SF works set in the very far future or in other universes where the parameter w is much more negative than seems to be the case in our universe.

Therefore, the implications are mainly philosophical. The ripping apart of the universe is a dismal picture. There may be a true End of Time that is approaching at a steady pace. And no matter haw hard we seek to achieve some immortality by creative acts that are preserved for posterity, the Big Rip promises to erase everything, without even the satisfaction of ultimate recycling implicit in the cycling Big Crunch or Big Clap scenarios. Perhaps the only escape from the inevitable Big Rip would be to create some extra-dimensional wormhole passage to a universe with less hostile parameters.

Perhaps we should be working on that, as a long-term goal.

AV Columns Online: Electronic reprints of over 120 "The Alternate View" columns by John G. Cramer, previously published in *Analog*, are available online at: *http://www.npl.washington.edu/av*.

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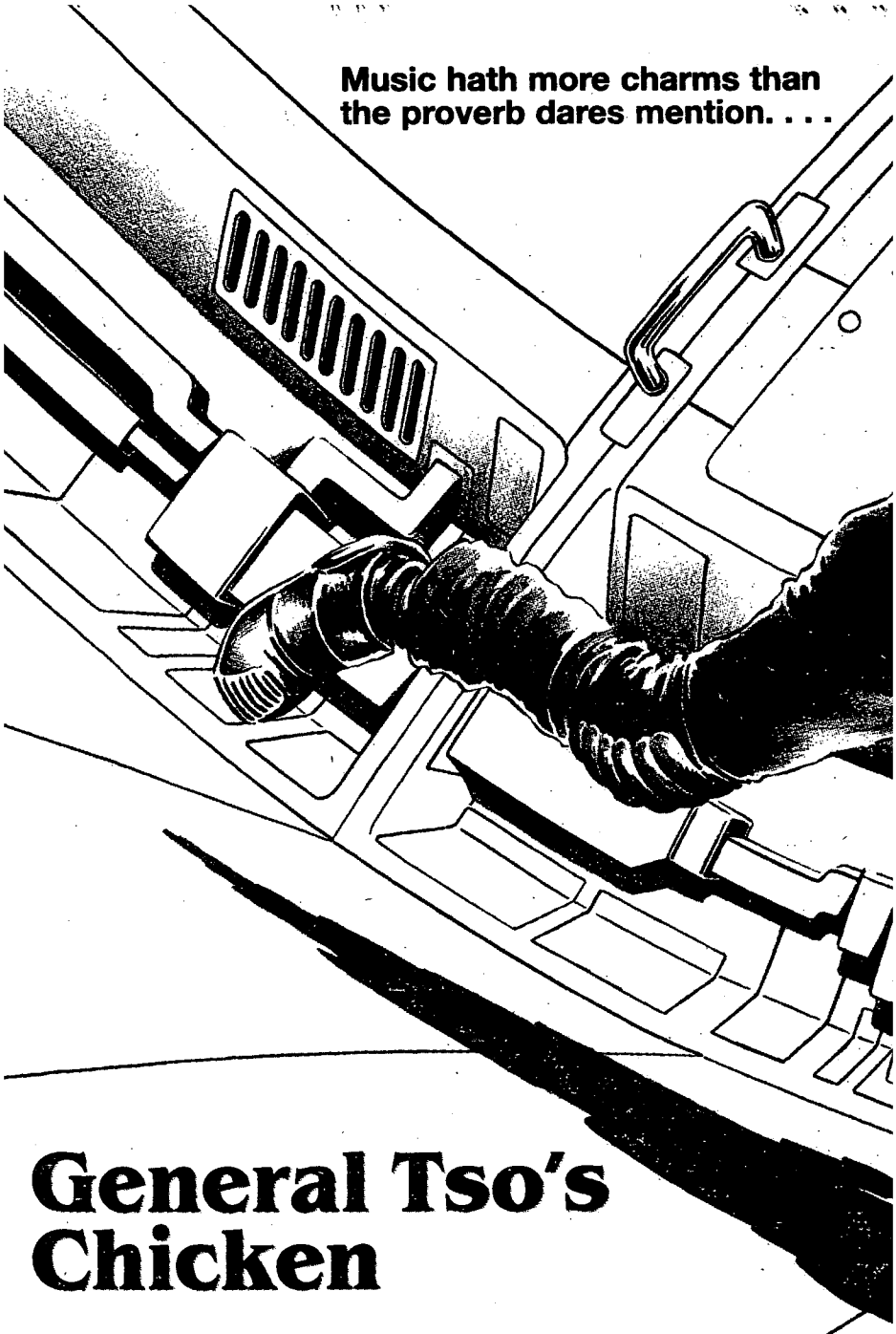

General Tso's Chicken

Carl Frederick

Illustration by John Allemand

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Kids! Commander Hendrix, hardly breaking stride, grabbed the paper plane drifting lazily through the central corridor. He crumpled it and jammed the wad into his flight suit. *If Admiral Searle saw this, he'd have kittens.* Then, magnetic heel-plates clicking against the nominal floor, he continued on to the *QWest*'s Space-dock Alpha.

Waiting at the lock, he looked out through a porthole and watched the inter-station shuttle, the *Shanghai*, dock with the *QWest*. He shifted his gaze to the horizon and could just make out against the fuzzy curvature of Earth, the only other space station in existence—the *Eastern Star*. By the variations in its brightness, he could tell it was spinning. *Simulated gravity. Damned space-hotel.*

Accompanied by a low rumble, the *Shanghai* latched to the dock. Then came a hiss as the shuttle equalized pressure with the station. Hendrix shifted his gaze toward the hatchway—and tried not to worry.

The junior-scientist prizewinners had been nothing but trouble ever since they boarded the station three days ago. Three middle-school kids reveling in their awards of a week on the *QWest*. It was localized mayhem. But if they'd misbehaved during their hour-long visit on the *Eastern Star*, it would be international mayhem.

Hendrix drummed his fingers nervously against the bulkhead. Things were a little touchy with China these days, and the last thing anyone needed was an international incident. He comforted himself with the thought that, at a ceremony in their honor, the kids would no doubt be on their best behavior. And anyway, Robinson was riding herd on them. His chief engineer had once been a junior-scientist prizewinner himself; he'd know how to keep them in line. And, how much trouble could kids possibly get into in one short busy hour?

As they scrambled in through the hatchway, Hendrix observed them. Philip, the tall, thin Scandinavian-American, looked unworried. Daniel, just as tall, but dark, had his usual smile. Then came the problem child—Kit. He was a head shorter and, at age ten, three years younger than the others—but a certified genius. Finally, Robinson ambled out into the *QWest*. All except Robinson had Cross media players hung from their belts and headphones covering their ears.

"Everything go okay?" said Hendrix, walking nonchalantly up to his chief engineer.

"Yeah. Of course," said Robinson.

"But boring," said Daniel, sliding his headphones from his ears to around his neck. The other boys did the same.

Robinson smiled. "Did you expect otherwise?" he said to both Daniel and Hendrix.

"I'm a worrier," said Hendrix, "and considering the—"

A station-wide announcement interrupted him: "Commander Hendrix, please. Call for you from the *Eastern Star*. General Tso on the line"

Hendrix jerked his head around and glared at the comlink. *The Commander himself. I wonder what he wants.* He stole a glance at the kids and began to worry again. They looked entirely too innocent.

He sprang to the comlink, stopping his motion by grabbing a float-handle and forcing his magnetic heels to a metal bulkhead. He hit the "Command Deck" button.

"This is Hendrix. Switch the Tso call down here, please." He waited for the beep and then said, "General Tso. It's good to hear from you. This is Commander Hendrix."

"Not a social call, regrettably," said Tso. "I'm most sorry to inform you that a plaque has disappeared from the *Eastern Star*."

"A plaque?" Hendrix saw the older boys throw a quick glance at Kit and then look absently at the ceiling.

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Kit fidgeted, pulling the fabric of his flight suit away from his body, as if the suit were too small for him.

"A National Award," said Tso, "held to a bulkhead only by magnetism—apparently insufficient protection against theft."

Hendrix started. Tso must really be angry to use such a strong word.

"Are you suggesting," said Hendrix, "that one of our junior-scientist prize winners has made off with it?"

"It is difficult to draw any other conclusion."

"I'm with the boys now. I'll ask them."

Hendrix, still staring at Kit, became aware of a plaque-sized bulge in the boy's flight suit. "Please excuse me for a moment, General Tso. I think we may have found your plaque." He pushed the mute button.

"Well?" said Hendrix.

Wordlessly, Kit unzipped his suit, pulled out the plaque, and handed it to Hendrix—all the while, looking down at his feet.

Hendrix released the mute button. "My apologies, General Tso. A misunderstanding. One of the boys no doubt regarded it as a souvenir. We'll return it when next the *Shanghai* visits."

"A misunderstanding, perhaps," said Tso. "But it is difficult to see it as other than a lack of respect. That boy must be disciplined." He paused. "Perhaps all the boys should be punished as they must have seen the act."

"Oh, I don't think that's necessary. That boy is very young and probably didn't realize what he was doing. And the other boys probably didn't even see it." Hendrix turned to the clump of kids. "You guys didn't see it, did you?"

"Yes, sir," said Philip. "We did see Kit take it."

Hendrix cast a quick glance at the ceiling.

"Ah," said Tso from the comlink. "Correction seems appropriate. If that is inconvenient for you, I suggest they be returned to the Star. I'm sure we can provide an appropriate response to their misdeeds."

Out of the corner of his eye, Hendrix saw fear and nervousness in the kids. "I think, General Tso," he said, "that we are quite able to handle things aboard the *QWest*."

"Excellent," said Tso. "Kindly call me back in an hour with your plan for correcting these vandals. Otherwise, I'll be forced to take it up with Beijing." Hendrix heard a click as Tso disconnected.

Hendrix faced the boys. "Explanations?"

The boys, eyes cast down, said nothing.

"All right, then. You'd better wait in your cabin while Robinson and I try to deal with this mess." Hendrix waved them off. "And stay there. We'll come over with news when we have it."

The two older boys set off slowly down the corridor. Kit, his small size making it hard to lift his magnetic boots, snapped free and propelled himself toward the cabin with the aid of the float handles set into the walls.

"We could just tell Tso to butt out," said Robinson when the kids were out of earshot.

"We could," said Hendrix. "But I understand Tso's position. Respect and not losing face is very important to our eastern friends. I'm sure he feels his honor is at stake."

"Come on." Robinson chuckled. "You just don't want to risk losing those Chinese fast-food care-packages."

"Well, I do admit looking forward to visits from the *Shanghai*." Hendrix blew out a breath. "All right. Let's go somewhere with a table and make a plan."

Hendrix, sitting at a table in the observation lounge, rested his thumbs against the seat belt that kept him from floating away. "Okay then. How do we punish our young geniuses—Kit in particular?"

Robinson, sitting across, shrugged.

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"We could slip him into an EVA suit and then keelhaul him."

"Very funny."

"Well, we can't send them to their rooms without dinner, and we certainly can't ground them." Robinson looked away, out a porthole. "You know," he said, "I sort of sympathize with the kid." He turned back to Hendrix. "I was barely thirteen when I went off to college."

"Seems a little young."

"It was good for me, actually. I'd been getting somewhat arrogant. But at Cornell, I learned pretty fast that I wasn't the smartest kid in the universe—or at least, not by much."

"But you must have felt very grown up, living at college and free of parents." Hendrix rubbed a hand wearily across his eyes. "Unlike Kit though, you must have been very mature for your age."

"No. And that's the problem," said Robinson. "Kit's problem as well. Supersmart kids often act younger than they are—to try to tell people they're really just kids and not little adults. Anyway, my cousin was a grad student at Cornell at the time. Both of us lived at a frat house."

"So he kept you in line."

"Well, in extreme cases. . . ." Robinson smiled. "Well, let's just say that the fraternity paddles decorating the walls were within easy reach."

Hendrix smiled. "I don't think we could use that technique here."

"Too bad." Robinson slapped the tabletop. "Considering how many people he's played pranks on, we could sell tickets."

"Yeah. I heard about his hacking into your computer and making the screen say 'I want my mommy' every half hour."

"I wish to hell I knew how he got root access to my system," said Robinson. "But that was nothing." He shook his head. "You really don't want to know the result of his playing with the vacuum system in their lavatory."

Hendrix unsnapped his retaining belt and stood. "This isn't getting us anywhere. We need a range of punishments."

"A range?"

"Afraid so," said Hendrix. "This'll probably come down to negotiation. We'll suggest a stern talking-to. They'll suggest a firing squad. And over time, we'll converge on something. It'll take a while. Maybe a long while."

"Jeez. I thought it's the kids who are supposed to be punished."

"All right," said Hendrix. "Suggestions."

Robinson leaned back in his chair, his feet resting in the foot loops. "First of all," he said, "what exactly, is your objection to a firing squad?"

"Understanding how addicted Western youth are to their music," said Hendrix into the lounge's comlink, "we propose confiscating the boys' Cross media players. And of course, we will insist the boys return the plaque to the Star and offer a full apology in front of your crew." Hendrix released the transmit button.

He looked across at Robinson. "Tso will laugh at this, of course."

A few moments later, came Tso's response. "Your proposal seems very minimal. Still, we will consider your comments and give you our response." There was a pause during which time, Hendrix heard Tso conversing in Mandarin. Then the General continued. "We'll radio you back in fifteen minutes. Tso, out."

"This'll take hours," said Robinson. "He wouldn't dare do anything without first consulting Beijing. General Tso's chick—"

"Don't say it," said Hendrix.

"Okay. Okay." Robinson gave a mock salute.

Hendrix glowered at the comlink. "All this over some stunt by high-spirited kids."

"More than one stunt." Robinson chuckled. "I think I should put in for

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hazardous duty pay."

"We don't have hazardous duty pay."

"I almost got knocked unconscious when I broke up their 3-D marbles game."

"At least you didn't drown."

"What? You mean the water pistol fight in zero-g?" Robinson drummed his fingers on the table. "Kit's idea."

"It took half an hour to suck up that mess." Hendrix threw himself back into his chair, grasping the armrests so he wouldn't bounce. "Maybe we *should* just send Kit over to General Tso."

"And how about the mechanical pencils?" said Robinson. "I had to stop the kids from playing darts with them before someone got killed."

"Ditto with their game of four-stage rocket."

"Four-stage rocket?"

"Where they hang on to each other," said Hendrix, "and one of them kicks away from the wall. Then the second stage kid kicks away from the first. You get the idea."

"Hey, neat. We used to play that at school—using swivel chairs."

Hendrix chuckled. "Yeah. I can imagine you doing that in middle school."

"Middle school? I was talking about grad school."

Hendrix threw a glance to the ceiling. "Sheesh."

The comlink crackled to life with the announcement that General Tso was on the line.

"Here it comes," said Hendrix. "The firing squad." He push-floated himself to the comlink.

"We have decided," said Tso, after an exchange of greetings, "to accept your proposal."

"What?" mouthed Robinson, noiselessly.

"Uh. That's very accommodating of you, General Tso," said Hendrix. "Thank you."

"There is a supply ship lifting off from Shen Zhang in a few hours," said Tso. "We will be occupied until it reaches us, unloads, and departs. Would it be convenient if we sent the *Shanghai* to fetch your party at 2200 hours UTC, and return them by 2330?"

"Yes," said Hendrix. "Quite convenient."

"Splendid. Until 2200, then. Tso out."

"What's going on?" said Robinson after Hendrix released the comlink.

Hendrix shook his head. "Maybe they just don't want an international incident—or don't have time for it. Who knows?"

"But is it safe?"

"Safe? You mean going over to the Star?" Hendrix shrugged. "The Chinese are absolutely true to their word."

"Still," said Robinson, "I'm a little nervous about this."

Hendrix gave a short laugh. "The Star is supported by tourists—especially western tourists. I'm sure they don't want to jeopardize that."

"I guess."

Hendrix stretched, then stood. "We'd better go and confiscate the players." He reached over to the comlink. "I'll let Langley know what's going on. They can inform Washington if they want."

Pausing in front of the boys' cabin, Hendrix and Robinson heard sounds of roughhousing coming from within.

"Sounds like they've forgotten all about their little transgression," said Hendrix, with a touch of anger in his voice.

"Oh, they're just kids." Robinson leaned in and listened close to the hatch. "I'm impressed how easily they've accommodated to life in space. Horseplay presents something of a challenge in zero-g."

Hendrix knocked. After a few moments, Philip, disheveled and breathless, opened the hatch. He and the other boys were dressed in tee shirts, shorts and socks—the normal station attire for informal duty.

Hendrix shook his head in wonder-

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ment. The cabin was a disaster—a mess in 3-D: Against the ceiling, a fleet of paper airplanes was arrayed in squadron formation, while under the dual influences of static electricity and air currents from the ventilation system, clumps of clothing—socks, underwear, shirts—floated lazily about the cabin like bubbles in a lava-lamp. Magazines, playing cards, books, and scraps of paper shared a gentle motion, giving something of the effect of an underwater ballet.

Hendrix grimaced as he remembered that Admiral Searle would be up from the surface soon for his bimonthly inspection. *The old buzzard would go ballistic if he saw this. And I'd really be in for it.* Hendrix made a mental note: *Just as soon as this Tso business is over, I'll make damn sure they clean up their cabin.*

Hendrix summarized the conversation with Tso, then asked the boys to surrender their Cross media players.

Daniel and Philip shot an angry look at Kit.

"It's not fair," said Daniel. "We're being punished for what Kit did."

"Sorry," said Hendrix. "But you guys are getting off easy."

"Easily," said Kit.

"What?"

"Getting off easily. Getting off is a compound verb, so you modify it with an adverb, not an adjective."

"Good grief," said Hendrix.

"He does this all the time," said Daniel.

Philip made a fist. "It makes you sort of want to hit him. Doesn't it, sir?"

"All right. All right." Hendrix held out a hand. "Just let me have your media players. You'll get them back at the end of your stay."

He collected a player from each boy. "And don't forget," he said. "2200 hours tomorrow. Chief Engineer Robinson will go with you to the Star."

Kit gazed innocently at Robinson. "How many engineers are there on the *QWest*?" he asked.

"At the moment," said Robinson, "just one. Me."

"Chief Engineer seems a little pretentious, don't you think? What are you the chief of?"

"Chief is a title."

"Like Chief Sitting Bull?" said Kit. "Are you an Indian?"

"Do I look like a friggin' Indian?" Robinson turned and stalked out of the cabin. Hendrix followed.

"I almost lost it back there," said Robinson when the cabin door had closed behind them. "Can you believe that kid?"

"Yeah, I know." Hendrix laughed. "He looks so innocent—like the illustration for the dictionary entry, 'kid brother'."

Robinson nodded. "You know, if the admiral saw the state of their cabin, he'd have a heart attack." He put a hand over his chest. "And then we'd have our very first burial in space."

"And if he didn't have a heart attack," said Hendrix, "we'd still have a burial—mine."

By the hatchway of Space-dock Alpha, Hendrix watched as the boys came aboard after their second visit to the *Eastern Star*.

He noticed that each boy wore a wide, black belt. Attached to each was a device—a media player, by the look of it. A cord tied around each boy's right leg just above the knee kept the gadget from flapping in zero-gee, and gave the device the look of an Old West gunslinger's holster. The two older boys wore earphones and from the way they moved—almost danced—they were clearly absorbed in some sort of music. Kit, with his earphones resting casually around his neck, looked at the other two with apparent disdain.

Hendrix was baffled. After agreeing that the players be confiscated, it seemed that the Chinese had given the kids new ones. *Incredible.*

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When Robinson came through, Hendrix pointed to one of the devices. "That's not what I think it is, is it?"

"No. Probably not," said Robinson. "Not if you think it's a Cross media player."

Hendrix gave Robinson a quizzical look and turned to the kids. "Why don't you guys hang out in the observation deck until lunch?" He pulled a headphone away from an ear of each of the bigger kids and repeated the request. Daniel and Philip nodded and ambled away, the clicking of their magnet-heel shoes sounding like a tap-dance in slow motion. Kit, as usual, floated free and began propelling himself along using the float-handles.

"Kit, wait," Robinson called out. "Can I borrow your player?"

"Yeah, sure." Kit pushed himself back to the deck. "I can do without Chinese rock music. Besides," he added, his nose in the air, "I only listen to classical music."

Kit untied the cord, released the belt, and handed it and the electronics to Robinson. Then he grabbed a float handle and hurried away.

"Chinese rock music?" Hendrix turned to his chief engineer. "Explain."

"Yeah, but let's go to my lab." Robinson glanced down at the tangle of belt and wiring in his hand. "I want to get this thing on the bench."

"Fine."

"Well, when we got to the Star," said Robinson as they started toward Engineering, "there were television cameras set up and running. The kids were well behaved. Kit apologized—not an impassioned apology, to be sure, but the Chinese didn't seem to notice."

"Was Tso present?"

"Oh, yes, indeed," said Robinson. "After the apology Tso said how unfortunate it was that the boys had to live without their media players. Then he presented gift-wrapped boxes to the boys." Robinson tapped a finger against the player. "I think the Chinese are using the occasion as a new product launch."

"I thought you said they weren't Cross media players."

"They're not." Robinson juggled the little device. "This belt has a low-frequency vibrator. The player takes a special card—standard ones don't work. When you play a card, the belt vibrates with the music's low frequencies—giving the feel of being at a live rock concert."

"But Chinese rock music?"

Robinson shrugged. "Daniel and Philip seem nuts about it." He paused outside the door to the lab. "But the main innovation is that the player adjusts the music to your heart rate and changes in blood pressure. There are sensors in the belt. The music changes—tempo, scoring, dynamics—that sort of stuff."

"Hmm. I wonder how they do that."

Robinson opened the door. "I'll let you know after I get it hooked up to a signal analyzer."

Hendrix gasped as he walked into the lab. "If the kids ever saw this," he said, "I'd lose all moral authority."

"Why?"

"Why? This lab is a disaster." Hendrix threw up his hands. "How could I ever demand the kids clean up their cabin?"

"I know where everything is."

Hendrix stared at the mess. Although some tools were neatly Velcroed to the worktable, others were tethered only by their power cords. Circuit boards and components floated unhindered through the lab.

"You do remember," said Hendrix, "that Admiral Searle will be here in about fourteen hours for his bimonthly inspection."

"Oh, God. So soon?"

"I think," said Hendrix, backing up to the door, "that I'm going to go off and get some exercise. Then I'll assign someone to ride herd on the kids to get them to clean up their cabin." He pointed a finger at his chief engineer. "Do I need to assign someone to ride herd on you

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as well?"

"Okay, okay. I can take a hint."

"Fine." Hendrix opened the hatch and as he left the lab, called back over his shoulder. "Let me know what you discover about the player."

"Will do."

On the way to his cabin after putting in a strenuous hour harnessed to a treadmill, Hendrix stopped in on Robinson.

The engineer looked up as Hendrix came into the lab. "What's wrong with this picture?" he said. "Reverse-engineering a Chinese consumer product."

Hendrix glanced quickly around the lab. It was even messier than before. "Do you know how that consumer product works yet?" he said, figuring that this was not the time to make an issue of neatness.

Robinson, seat-belted to a lab chair, swiveled around from an oscilloscope. "The player responds to changes in pulse and blood pressure." He pointed to the player now thick with test leads. "It changes the cadence and composition of the music accordingly. And the belt does indeed simulate bass-note vibration over the body. But the Cross cards here are not recorded music. They're TransMidi files. The software in the player reconstitutes the sound on the fly."

"TransMidi files?"

"A glorified musical score." Robinson nodded toward a computer monitor where data scrolled down the screen. From the computer's speakers, Chinese rock music played softly in cadence with the monitor display. "The file has information on the notes," said Robinson. "How the notes are played, what instrument plays them, and how they're played." He pointed at Hendrix with a scope probe. "Film scores have been done in TransMidi for years, but it's taken a roomful of equipment."

"Clever." Hendrix, avoiding floating test-leads and electronic components, made his way over and peered at the player. "But now that you know how it works, I suggest you reassemble it and give it back to Kit. I imagine he's feeling sort of isolated since Daniel and Philip have theirs."

"I don't think we should return it." Robinson stabbed his scope probe into a cube of polyurethane foam Velcroed to the lab table. "In fact, I think we should confiscate the other two."

"What?" Hendrix wrinkled his nose. "Why?"

"I think they're dangerous. I don't like the way the kids became obsessed with them."

"I can't just take away the players," said Hendrix. "Not when they're gifts from the youth of China to the youth of the West."

Robinson slapped a hand to the table. "I think the kids are clinically addicted to them."

"I think you're overreacting."

Robinson scowled, but didn't say anything.

Hendrix glanced at the computer and listened to a snatch of the music. "In any case," he said, after a moment, "I don't think it'll do any incurable damage to return Kit's player."

"Incurable!" Robinson jumped up, but the belt forced him back down on his chair. "That's it. That's the model."

"What are you talking about, please?"

"The disease model." Robinson made a fist in the air. "I'd been trying to figure out how to explain the addiction, and now it makes sense. The player is a lifeform. Jeez. I'd heard Philip say 'Music Lives'. I should have believed him."

Hendrix looked hard at the engineer. "If you're trying to finagle more sick-leave, it's not going to work—not unless you're *dangerously* insane."

He'd worked with Robinson for years now and had never quite gotten use to the man's wild imagination. But the guy was brilliant and had performed near miracles on occasion.

Robinson swiveled back to his test equipment. "Symbiosis or a parasite?"

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He twiddled some dials on the oscilloscope and pulled the probe free of the polyurethane. "Parasite. I'll assume a parasite."

"You're serious, aren't you?" said Hendrix.

"You have a very narrow notion as to what constitutes life," said Robinson, without looking away from his instruments. "And you do know that the full human genome can fit on a single Cross media card, don't you?"

"Okay, okay," said Hendrix. "I'll certify it. You're dangerously insane."

Robinson chuckled, softly. Once more, he swiveled around to face Hendrix. "Humor me," he said. "Use your imagination and pretend the media player and card is a life-form. Do it just as an exercise."

"Yeah, fine." Hendrix shrugged. "The life-form reproduces by kids copying the cards and passing them around." He stopped for an instant to think. "And it stifles the competition by causing the listeners' hearing to go bad, rendering them unable to appreciate Mozart."

"You're saying it as a joke," said Robinson, "but you're right. And the life-form evolves by people like me improving it." He smiled. "I am an agent of evolution."

"What do you mean, 'improving it'?" said Hendrix. "I get nervous when you say things like that."

"What *do* I mean?" Robinson closed his eyes. From long experience, Hendrix knew it was best to just wait.

A minute or so later, Robinson blinked open his eyes. "How do you fight a disease life-form?" He didn't pause for an answer. "With a vaccine—in this case, a live vaccine."

"Meaning?"

"Meaning that I'll build a super player to counteract the Chinese units." He looked over at the media player. "Heck, no. I'll just modify Kit's unit. Kit won't miss it. He's a classical music fan. You'd have to tie him down to make him listen to rock." Robinson pulled the test leads off the little player.

"Um," said Hendrix. "These modifications. What do you have in mind?"

"I'll use brain waves in addition to pulse and heartbeat."

"With electrodes going into their brains, no doubt," said Hendrix, knowing that Robinson couldn't detect sarcasm when he was in an engineering frenzy.

"Nah," said Robinson. "Just surface electrodes on the temples." He extracted the circuit board from the player and pointed to a chip. "Standard N88-900 processor. And here's the program Rom." He shot a glance at Hendrix. "I'll try to evoke heroism—doing great things, and that sort of stuff."

Robinson sat back and clasped his hands behind his neck. "This'll be fun. I'll have to integrate the player with the computer, but that won't be a problem." He unclasped his hands and moved a magnifier over the circuit board. "I think I'll use Wagner: The Ride of the Valkyrie if I can find the file to upload." He slapped the Chinese rock music card onto the lab table. It bounced off and drifted into the general mess that enshrouded the table. "We fight the Chinese strain with a Wagnerian strain."

"Very funny," said Hendrix.

"The Ride of the Valkyrie's powerful stuff," said Robinson as he examined the board under the illuminated lens.

Hendrix stood. "I know there's no talking you out of one of your engineering binges," he said. "But you have to be finished in . . ." Hendrix thought. ". . . in eight hours, max." He walked to the door. "Then we have to prepare for Searle's visit. And since Tso's also coming over to meet with the admiral, I want Kit to have his player back—just in case Tso makes an issue of it."

"Hmm," said Robinson, clearly oblivious to anything but the little circuit board.

"And, for godsakes," said Hendrix, looking back over his shoulder. "Clean up this lab."

"Hmm."

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* * *

In his cabin, Hendrix sprang from his hammock, jolted out of his sleep by The Ride of the Valkyrie coming full-blast from the comlink. He hit the com switches, but it was no use. He couldn't communicate with the command deck.

He dressed, then darted out of the cabin. "What the hell's going on?" he asked of the first crewmember he saw.

"I don't know," the crewmember shouted over the din.

Then, over the music, Hendrix heard the shout, "Ho-jo-to-ho," the war cry of the Valkyrie. It was Robinson's voice.

"Damn." Hendrix gritted his teeth. *He's completely lost it.* In a combination of running and pull-floating, Hendrix scrambled to the Engineering lab.

He knocked at the door.

Nothing.

Then he pounded on the bulkhead. "Robinson. Open the door."

Still nothing.

After hammering until his hands hurt, he hurried off to the command deck. There, he found two crewmembers. They'd activated the emergency remote-TV camera in Engineering and had it trained on Robinson.

Hendrix peered over their shoulders at the screen. Robinson, electrodes secured to his temples by a headband, waved his hands to the music.

Hendrix cupped a hand over a crewmember's ear. "Can't we shut down that damn comlink?"

"I don't think so." He laughed almost hysterically. "Robinson probably could do it if he were here."

"I'm an agent of evolution!" came Robinson's voice shouted from the comlink.

"Oh, great." Hendrix tapped the crewmember on the shoulder. "Okay, then. Is there another way into the lab?"

"There's a ventilation and wiring duct, but you'd have to be a little kid to get through it."

"A Kit-sized kid?"

"Yeah. I think Kit would fit. Access from the supply closet next to Engineering."

"Thanks much." Hendrix turned and made for the boys' cabin. The door was slightly ajar when he got there. Kit wasn't inside, but Philip and Daniel were.

The boys were cocooned—held captive by tie-down cords threaded through their sleep-hammocks. Struggling to break free, they squirmed in their sleeping bags causing their hammocks to jerk erratically like leaves in a wind.

"Oh, for godsakes," Hendrix muttered. He untied Philip and Philip untied Daniel.

"Wait until I get my hands on that monster," said Daniel, practically shouting just to be heard.

"If there's anything left of him after I get through with him," said Philip in an equally loud voice.

"Before you kill him," said Hendrix over the music, "send him to me. I need him."

Daniel nodded toward the comlink. "Can't you do anything about that noise?"

Hendrix cast a glance to the ceiling, then, without saying anything more, bolted from the cabin.

After a frenzied search, he found Kit in the observation lounge.

"Neat," shouted Kit as Hendrix ran in. "Ride of the Valkyrie." He shook his head. "But nowhere near as good as the Bayreuth Opera performance under Klaus Von Brauberg."

Not trusting himself to speak, Hendrix grabbed Kit by the arm and dragged him out of the lounge.

"Where are we going?" said Kit in a frightened voice. "It was just a joke."

"We'll discuss jokes later," said Hendrix. "Right now, I need your help in Engineering."

"Oh."

Hendrix explained the drill as they rushed along.

At the storage closet next to the lab, Hendrix flung open the door, and found the tiny room filled to the ceiling with

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large metal storage boxes, each secured to the walls with tie-down cords. The crates completely blocked access to the ventilation duct. But at least there was no comlink in the closet; one could be heard without shouting. Hendrix blew out a breath. "Okay," he said. "Let's clear these boxes out of here."

In the tight space, Hendrix and Kit released the containers from the walls and, sacrificing care for speed, let the boxes float free, like marauding icebergs, down the passageway.

Once there was room in the closet, Kit leapt and caught hold of the ventilation grillwork.

"It's held on by clips," said Hendrix from below. "You can just pull it off."

Kit pulled away the grill and slithered into the duct.

"Go straight for the door lock," Hendrix called out. "Unlatch it and get out of the way."

When Kit's feet had disappeared into the darkness, Hendrix darted out and then stood waiting in front of the lab door.

At the sound of a click, Hendrix threw open the door and darted toward Robinson.

"*Halten Sie, bitte.*" Robinson flourished a scope probe like a sword. "*Notung. Notung, niedliches Schwert.*"

"Robinson, snap out of it," Hendrix shouted. He waved his hands as a distraction while working himself around to where he could kill the power to the computer. When he hit the power switch, the music abruptly stopped. Robinson slumped in his chair, and then sat bolt upright.

"Oh my God." Robinson pulled off the headband and electrodes. "Jeez. It was like . . . I don't know—an epileptic seizure, maybe. I knew what was going on, but I couldn't do anything about it." He wriggled his shoulder blades. "Really scary, but boy, what a high."

Kit stepped out from behind the door. "I have to admit," he said, "that even I am tiring of hearing 'The Ride'." He walked over to the lab bench and examined the player.

Hendrix hovered over Robinson. "I want Dr. Olafsson to have a look at you. And I've no doubt he's awake at the moment."

In his cabin a half hour later, Hendrix breathed a long sigh of relief. He activated the comlink to let the command deck know everything was under control. But he couldn't get through. "Damn." Hendrix realized that even though they'd stopped the music, the lab's comlink still had control. He'd have to go over, pull out the audio cable and switch the box to "ready."

Hendrix had gotten most of the way to the lab when, all at once, The Ride of the Valkyrie came blaring as loudly as before from all the com speakers.

"What the hell?"

He bolted full-out for the lab, but stopped short as he again heard "Ho-jo-to-ho." The voice was vaguely familiar.

Then, with a shock, he recognized the voice.

"Tso!" Hendrix slapped a hand to his head. "That's all I need right now."

Then he remembered that General Tso was scheduled to arrive for a meeting with Admiral Searle. It was Tso's habit to arrive early. *Hell! That means Searle's on his way as well. He'll kill me when he sees what's going on here.*

At the lab, Hendrix found the door locked. "Damn it!"

He didn't know precisely what had happened—how Tso came to be hooked up to Robinson's player. But this time, he knew what to do.

Hendrix sprinted to the observation lounge to get Kit. But the boy wasn't there.

Muttering under his breath—not that anyone could hear anything with 'The Ride' blaring out—Hendrix ran to the kids' quarters.

The door was locked. He knocked, but with all the noise, he knew it'd be a miracle if anyone could hear him.

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Hendrix put his ear to the bulkhead and listened. He heard muffled shrieks, and also a slapping noise—clearly the sound of a belt striking soft anatomy.

"Not now!" Hendrix pounded harder on the door. After another half-minute or so, he took off a shoe and hammered it against the door—not an easy task, as he had to constantly pull the magnetic heel away from the metal door.

The shrieks from behind the hatch stopped and about a minute later, Daniel opened the door. Hendrix stepped in.

Philip stood against the far wall with Kit at his side. Philip looked scared.

Hendrix, observing Kit's red eyes and a slight quiver in his lower lip, asked, "Kit. Are you all right?"

"Yes, sir?"

Sir? Hendrix went up to the boy. "I need you again," he said, loudly, over the music. "Same drill as before." He urged Kit toward the hatchway. "And hurry." He looked over at Daniel and Philip. "You might want to strap on your media players. It wouldn't hurt to earn some points with General Tso at the moment."

"Do we have to, sir," said Philip.

Hendrix gave a quizzical look. "I thought you guys were nuts about those players."

"We were," said Daniel. "But after a while it got boring. And Chinese rock music really sucks."

"Well, wear them, anyway," said Hendrix. "Pretend to enjoy it. And we'll talk later about what happened in here."

With "The Ride" reverberating through the cabin, Hendrix and Kit rushed out of the kids' quarters. With Hendrix on foot and Kit using float handles, they headed toward the engineering lab.

"You wouldn't happen to know how General Tso happened to be hooked up to the player, would you?" said Hendrix.

"When you took Mr. Robinson to his cabin," said Kit, "I stayed behind in the lab. General Tso came looking for Mr. Robinson and I told him about the player. I bet you didn't know General Tso was a Wagner fan."

Hendrix gritted his teeth.

"Anyway," Kit went on, "I talked him into letting me connect him to the player."

"That wasn't very nice," said Hendrix. "You knew what the player did to Robinson."

Kit was silent for a few seconds.

"Mr. Hendrix," he said, finally.

"Yes."

"I could temporize or perhaps rationalize my actions."

"What?"

"My behavior was iniquitous," said Kit. "I'm sorry."

Jeez! Hendrix shook his head. "Apology accepted."

As they reached the engineering corridor, they dodged the floating storage boxes and then sped toward the closet.

"Oh, and Kit."

"Sir?"

"When next you need to apologize, use simple words. Try to talk like a kid."

Kit giggled. "I'll try."

Since the closet stood empty and the ventilation grill had been removed, Kit sprang directly for the duct, and scrambled in. But no sooner had his feet vanished into the darkness than the music stopped.

Hendrix, realizing that Tso would no longer be incapacitated by Wagner, shouted up to Kit. "Come back. Don't go into the lab."

Hendrix heard some shuffling sounds, and then Kit's voice. "I can't come back. I'm stuck."

Just then, Hendrix heard a cry of pain from the hallway and then Robinson's voice. "Damn it to hell! Who let this bloody box float free?"

Hendrix peeked out into the passageway. "Robinson. In here."

"What about me?" shouted Kit from the duct.

"Hold on," called Hendrix. "I'll get to you in a second."

Robinson stuck his head in. "What're

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you doing in there?"

"Trying to get into the lab to turn off the music."

"Wouldn't it have been simpler to just turn off power to engineering?" Robinson looked up at the exposed duct. "Which is what I did after 'The Ride' woke me up."

Hendrix threw up his hands.

"Anyway," said Robinson. "I just wanted to let you know that Admiral Searle's arrived."

"What? He's here?"

"His ship's just docking now. I tried to call you to the command deck but the comlink was out. I couldn't even find you."

"Oh my God." Hendrix buried his face in his hands for a moment, then looked up. "Take him on a tour," he said. "Show him the observation deck, the kitchen, hell, even the water reclamation system. But for godsakes, keep him away from Engineering."

"Fine. But he'll want to see you."

"Well, tell him I'm in the lavatory."

"Get me out of here!" came Kit's voice, echoing from the duct.

Hendrix waved Robinson away. "I'll explain later," he said. "Go."

As Robinson set off, Hendrix heard another voice coming from the duct.

"I'll help you get out." It was General Tso's voice.

Hendrix heard the sounds of Kit being pulled out, and then Kit's voice.

"Let me go. Hey! What are you doing? Let me up. Oh, no. Not again."

Then Hendrix heard slapping sounds followed by howls of pain.

"Leave him alone," Hendrix shouted. He ran out of the closet and started pounding on the Engineering lab's door.

"General Tso," Hendrix bellowed. "Open this door at once"

A few moments later, Tso opened the door and stepped aside. Hendrix rushed up to Kit. The boy, red-eyed and sullen, had his hands pressed against the seat of his pants.

Tso walked up, and Kit stepped back.

"As a parent," said Tso, "I can assure you that the boy was crying much more vigorously than my actions warranted."

"You shouldn't have done that," said Hendrix.

"I believe he required it." Tso sat, holding himself in the chair with his hands. "I believe I am the injured party." Tso gave a quick nod of his head. "But honor is satisfied, now. If you don't make an issue of it with your government, I will not bring it up with mine. We can end the incident here. Yes?"

Hendrix glowered at him, but had to agree. There was no need for an international incident, and Kit probably had it coming. "Yes," said Hendrix.

"Good," said Tso. "Has your Admiral Searle arrived yet?"

Hendrix nodded.

"Excellent. I shall go now to have a pleasant visit with him."

Hendrix let out a breath and took a quick glance around the lab. "My honor as well as something else will be in a sling when the admiral sees the mess in here."

"Regrettable," said Tso. "Surface-based officers often have little knowledge of the conditions we face." He stood, bowed slightly and, walking awkwardly in his guest-issue magnetic heel adapters, left the Engineering lab.

It took a few minutes for Kit to recover, and Hendrix gave him the time. Even so, Kit seemed in too fragile a state to be left by himself or to be fobbed off on another crewmember. So, Hendrix took him along as he set off for the command deck. Hendrix wasn't looking forward to his meeting with Admiral Searle, knowing he'd likely receive the verbal equivalent of what Kit had just endured.

When they arrived at command, Admiral Searle and General Tso were already there. Robinson, as second in command, was there as well.

"I'm sorry you had an upset stomach," said Searle.

"What?" said Hendrix. Robinson flashed him a glance. "Oh, yes. I feel

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much better now, sir. Sorry to keep you waiting."

"No need to apologize," said Searle. "I've had a nice chat with General Tso. But the inspection tour will have to wait until my next visit."

"Sir?"

"General Tso," said Searle, "has invited me to lunch on the *Eastern Star*. In fact, he has insisted." He turned to Tso. "I've heard your General Tso's chicken is not to be missed." Hendrix shot Robinson a "don't even think it" glance. "Must keep the honor of your family name, eh, General Tso?" said the admiral.

The General faced Searle, but his eyes found Hendrix. "Honor is very important." He flashed a quick smile.

Hendrix smiled back and gave the hint of a bow. *Thank you, General Tso, for saving my butt.*

Searle turned from the General. "But I did see your cabin," he said, looking sternly at Kit. "In the old days, ship's boys would be whipped for keeping their quarters in such condition."

Kit took a step sideways—closer to Hendrix.

Searle laughed. "Don't worry. We don't do that these days. Still, you had better clean up your cabin."

"I will, sir," said Kit. "I'm sorry."

"Good lad." The admiral waved an arm expansively toward Hendrix. "Commander Hendrix runs a tight ship—or space station, in this case."

Behind Admiral Searle, Hendrix saw a storage crate floating down the corridor. He prayed that the admiral wouldn't turn around. ■

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CARL FREDERICK

Carl Frederick considers *Analog* a world-class cultural institution that visualizes the glories of science. *Analog* early on became life-long reading for him. A B.S., M.S., and Ph.D. in physics came after a bitter struggle with public schools that he declares deaden intellectual curiosity.

Astronomy was also an early fascination. Born in Australia, but growing up mostly in New York, he spent much happy childhood time at the Hayden Planetarium and in the American Museum, where he joined the Junior Astronomy Club. Back then, a live lecturer controlled the great Zeiss projector and showed real heavens past, present, and future. Today's canned multi-media extravaganzas he says no longer acquaint people with the splendor of the firmament. He also went on tour with the Metropolitan Opera's Boys Chorus under Rudolph Bing. Entirely of his own wish and love for music, he studied the violin. Forcibly turned right-handed at school, he lacked the necessary deftness. His violin teacher in compensation or perhaps despair showed him how to play classical pieces on a soda straw. Naturally enough, this led to the bagpipes, with which he skirls *piobaireachd* Scots tunes. Much later, a shoulder injury forced him to fence left-handed, and he won a national rating with the epee. As a university undergraduate, he was distracted by chess. Approaching Master level in tourney play, he was actually in danger of flunking out. His salvation was coming across a sixteenth century essay characterizing chess as an ingenious recreation better traded for pursuing some noble science.

After years of scientific education, he finally felt at home in the famous Belford Graduate School of Science in New York. While it existed, the faculty included some of the most prestigious names in science. He took courses with Paul Dirac, creator of Quantum Algebra, and learned Relativity theory from Peter Bergman, one of Einstein's six most famous students. Carl sat in the same astrophysics class with Freeman Dyson, who was auditing that course taught by Hugh Cameron. Carl notes this world-class astronomer had been a young SF fan. Carl's post-doc fellowship was sponsored by NASA. Formally a theoretical physicist, sometimes led astray into "forbidden" experimental territory, Carl presented a Ph.D. thesis entitled "Far Infra-Red Astronomy and the Galactic Center." He published papers in Stochastic Space-Time theory, infrared astronomy, and quantum measurement theory. At NASA's Goddard Institute, he designed, built, and flew balloon telescopes for far infrared observations.

Carl invented the world's first digital modem and founded a company to manufacture it. All this while a vegetarian and scoutmaster for a troop of high-ability kids. Business wasn't much fun, though, and he left to return to Ithaca and its great Cornell University. Icelandic studies and language became his passion there. Among other accomplishments, he can recite passages from *Beowulf* and converse in Swahili with *Analog* editor Stan Schmidt.

Like many readers of SF down through the years, Carl thought he would like to write it, too. During Y2K, he spent six weeks at the Odyssey SF Writer's Workshop. Carl declares that he has concentrated on physics and math, avoiding all biological science and the humanities. Still, he placed as a finalist in the 2002 Writers of the Future contest, established by old-time *Analog* writer L. Ron Hubbard. Carl went on to a $1000 First Place prize in 2003. That same year, he appeared in the July/August and September issues of *Analog*, and then again, in the April 2004 issue. He is now the chief scientist of a company that develops custom software for specialized uses. "I do far too much computer programming," he says. ■

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"Choose your battles" is good advice—if you're free to folow it.

Illustration by Vincent DiFate

HE TONEHENGE GATE

rt II

ck Williamson

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Synopsis of part I

Back at home before it all began, we called ourselves the Four Horsemen, though none of us owned a horse and Lupe was a woman. We were teachers at our small New Mexico college. **Lupe** *was an anthropologist, searching out the origins and history of early man.* **Derek Ironcraft** *taught physics. I'm* **Will White**, *telling the story.*

Ram Chenji *was the oddball. Born in Kenya, of mixed ancestry, he spoke of a strange great grandmother, a little black woman who said she had been a slave on another world. He carried a birthmark she called "the crown of worlds." Before she died, she gave him an odd emerald pendant she said had let her escape, "though the gates of hell."*

Derek came back one fall from a summer internship with NASA. With penetration radar, he had found what looked like a larger Stonehenge buried under the Sahara. When the Christmas vacation came, we pooled our resources, flew to Tunis, and chartered a chopper to take out over the Grand Erg Oriental.

We found the columns of a massive trilithon jutting from a vast sand dune. The radar image showed the fallen lintel stone. Ram walked between the columns and fell into a circle of great black megaliths on a dead world he couldn't breathe the air. Gasping, he climbed back to join us.

After that narrow escape, we returned to Tunis for oxygen gear. All of us together, we tried the key again. I felt the shock of a different gravity when we walked between the columns. My ears clicked to the pressure of a different atmosphere. Massive trilithons towered around a circle littered with bones of men and monsters that had died there.

A monstrous thing hopped out of nowhere and dived at Lupe while she was collecting specimens to study. Something with long metal legs and a bright silver skull, it seemed half machine, half alive. Gliding down on stubby wings, it snatched her off the floor and hopped high again to dive at us.

In panic, we ran through another trilithon. Another gateway, it took us to yet another planet. We found ourselves on a moving pavement that carried us out into a strangely Earth-like landscape, where animals and planets looked familiar. Another enormous hopper followed, and stopped on the pavement as if to watch us.

Always hoping to find Lupe or some clue to her fate, we let the pavement carry us on. It took us through the monumental ruins of a vanished civilization, past the monumental figures of a black man and a white woman, seated side by side on a throne. Strangely, both their foreheads bore birthmarks identical to Ram's. Farther on, we saw the abandoned ruin of an enormous fortress and a vast battlefield hidden below a virtual world, relics of a conflict that seemed to have left no survivors.

The constellations were strange when we saw the night sky. The gates had taken us far across the galaxy, Derek didn't know how. The planet was double, the close twin world a huge moon that eclipsed ours every day. The road carried us to a skywire between them. Multicellular robots operated an elevator that lifted us to a city on the sister planet. It was empty, but well tended by waiting robots waiting for people to return.

Sadly, we lacked any language to command them. We were hungry. Though food was abundant, they gave us none. When we tried to take it, they pursued. We ran for a trilithon. Another gigantic hopper joined them. Derek turned and waited to let it snatch him up. His only chance to reach Lupe.

Beyond the trilithon, Ram and I found ourselves at the foot of another on a flat mountain summit, a lush

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jungle landscape far below. We met people still alive. A runaway slave limped by us, seeking escape from a gang of black pursuers. Ram knew a little of their language, leaned from his great-grandmother. They knelt around him when they saw the crown of worlds, taking him for the son of the god Anak, expected to return and liberate their race.

"I don't know what to think," he told me. "I never quite believed all my little Mama told me about hell and how she got away. I never understood why she and I both wore the birthmark. In spite of all she said, I never expected any magic destiny."

We learned a little about the planet's two great continents, Norlan and Hotlan. Norlan lay around the pole, capped with ice, with only narrow strips along the coast inhabited. Hotlan sprawled across the equator, most of it drained by the great Blood River. It was half unknown, the vast eastern rain forests roamed by nomad tribes and scattered with the monumental ruins of the dead civilization. The Norlan whites ruled the river from Periclaw, their seaport city on the delta.

Toron *took us and his captive slave down the mountain and through endless miles of jungle, back to* **Hake**'*s trading post and a little red brick fort on Blood River. Toron delivered the captive to the Norlan agent at the fort and got Trader Hake to put us up in his walled compound. The fugitive slave, still alive, was hanged in front of the fort with a hook through his ribs.*

"We're in an iffy fix." With a finger on the birthmark, Ram gave me a quizzical look. "It's the crown of thorns that worries them. They're afraid me, afraid I'll set off another slave rebellion. Hake doesn't want any trouble that might wreck his business. The agent wants no problems with his bosses in Periclaw." He grimaced at the slave, still gasping for life in the tree. "They'd like to string the two of us up along with him."

Part II

15.

Trader Hake put us up while the agent waited for orders from the high commission.

"Not because we're welcome guests," Ram said. "Toron tried to convince him that we really came here through the trilithon, sent from heaven to change the world. He seems certain we're con men destined to be hanged. Either way, he sees us as a danger to his way of life. Just in case we really are divine envoys, he wants to play it safe."

The trader's wife, Lela Lu, seemed more cordial. She was a thin blonde with honey-colored hair that hung free below her shoulders. She had pale blue eyes and a wistful smile that seemed shyly appealing, but her fair face showed lines cut by a life that must have been unkind.

She guided us down a long hall to a corner room at the back of the building and called a black maid to bring hot water for the bathtub. We bathed and let a black barber shave us. She brought her son to meet us. A bright-eyed child of seven or eight, he was nearly as dark as Ram.

"My name is Kenleth Roynoc." He extended his open hand to Ram, palm up, and blinked in a startled way when Ram shook it. "What is yours?"

With no fear of us, he was fascinated. He wanted to examine my watch and touch Ram's magical birthmark, and he asked questions we couldn't answer about the haunted trilithon and how it worked. That night his mother sent him to call us to the family dining room. Two black waiters served the meal. There was excellent, hard-crusted bread, but most of the dishes were strange, with no names Ram could translate. I was hungry enough to enjoy them hugely.

Kenleth kept asking questions till his mother hushed him. She had little to say.

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The trader watched us sharply, with shrewd queries of his own, hoping I think for incriminating slips. When we sometimes failed to understand him, he offered to let his wife teach us the language. Hoping, I suppose, that we would give ourselves away. She gave us lessons as long as we were there. Never seeming to doubt us, she told a pathetic story of her own exile from civilized society.

"I was born in Periclaw," she said. "My father was a history professor. He was interested in the native culture and the relics of the lost civilization. He took me to hear Gauran Roynoc, a black singer. We met at a dinner after the concert." Old pain pinched her face. "He became Kenleth's father."

She showed us a tiny bust of him, carved in polished jet that she wore on a gold necklace.

"He was a registered freeman, a native of the Roy-Roynoth tribe, nomads that range the northwest rain forest. An explorer heard him at a tribal ceremony and brought him back to civilization." Emotion softened her voice and misted her eyes. "He had a fine voice and he sang the sacred songs of his people. Oral epics based on myths of the lost empire, maybe composed before the art of writing was lost."

She wiped her eyes.

"I knew him several years. His songs made him a celebrity, but he also took my father's classes, did research in archeology and finally became curator of the antiquarian gallery at the museum. I was his secretary. We traveled together up the river, collecting historic artifacts the natives sometimes brought out of the jungle. And—"

Her voice broke.

"I became pregnant. That would have been a sentence of death for the child and me. My father wanted to arrange an abortion, but I couldn't kill Gauran's child. I'd met Ty Hake on one of our trading trips, and I came down here to have Kenleth."

Her shrug seemed more resigned than joyous.

"He's been good to me, but I do miss the city." She wiped her eyes again. "Gauran was hanged before Kenleth was born."

The agent made a ceremony of giving Toron his bounty money. Ram and I, along with the trader's family, were seated in folding chairs set up on the agency lawn, facing the old oak on the drill field and its evil-odored fruit. The agent's black mistress escorted Toron to join us. The guard detachment, six men in stiff white uniforms, marched out of the fort to the beat of a drum and waited at attention.

The agent came out in a white jacket to stand beside the prize waiting on a little table. He signaled for another roll of the drum. With gestures at the flag flying over the fort and the half-stripped bones in the tree, he read a speech about the dignity of justice and the blessings of life in the World Union.

The drums beat again. He called Toron forward. His black mistress presented the prize. Five burlap bags, each stenciled with symbols Hake's wife read us:

CORATH
ONE THOUSAND
TOP GRADE BEANS

After we left, she showed us a corath tree growing in a high-fenced yard in the compound, a savage-looking dog chained to it. It had long, leather-like leaves and little pink flowers with an evil odor. The flowers and the fruit pads grew directly out of the thick trunk, not from branches. The ripening pods were violet-colored, shaped like footballs and about the same size.

"The agent planted it here, to find if it can be cultivated." She looked vaguely distressed. "That outraged the natives. The corath is sacred. The wild trees grow only in spots called the gardens of Anak, where he is believed to have planted them. Members of a holy broth-

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erhood drink the tea to see their way to paradise. Gauran said corath had been the inspiration for his songs.

"For an unbeliever to touch the tree is a desecration, yet many risk their lives to harvest the beans. They're money here on the river. My husband accepts them for trade goods and grinds them into paste for sale in Periclaw."

She made a bleak grimace.

"A dangerous trade. Forbidden by the blacks except in the holy rites and illegal to the high commission unless a high excise tax is paid. But my husband says other would make the profit if he stopped."

She showed us the building where the raw beans were fermented, dried, roasted, and bagged for shipment.

"It's our cacao," Ram told me when we were alone. "The source of our own chocolate. I've seen the trees back in Africa. I suppose it has mutated or been engineered to carry some stronger narcotic."

We were together there at the landing nearly two weeks. The Periclaw authorities must have been as uncertain what to do about us as the agent himself. The first packet to come up the river brought him no orders for us. Waiting, with nothing better in sight, I grew more and more uneasy.

"Let's learn all we can." Ram was philosophic. "Something we owe to Lupe and Derek."

He asked Hake's wife about the history of the planet.

"Most of it's lost." Wistfully, she shook her head. "Norlan history goes back a thousand years, but the early people were too busy fighting the ice and one another to care about much else. They had no contact with the south continent until white explorers began cruising along the coast and up Blood River.

"My father was a student of what he called prehistory, but nothing to base it on except artifacts from the ancient ruins on the old civilization and the folk tales of the blacks. If you care about those myths and legends, the history of the world began when Anak and Sheko came through that gate on the sacred mountain the way you did."

She waited for Ram to nod.

"They planted trees and put fish in the seas and freed the birds to fly before they brought the first men. Anak ruled the world in peace and shared his powers to let men build the gates to heaven, as well as the cities and temples that the jungles buried after Sheko killed him."

"Myths?" Ram asked her. "What do you believe?"

"My father looked for some truth behind them." She frowned. "I worked with Gauran, collecting for the museum. Enormous ruins still stand. Tombs are found, filled with tantalizing artifacts. Walls are covered with writing nobody can read. There's Anak's pyramid, with Sheko's curse upon it. And the gate to heaven that takes you nowhere."

Trouble seamed her care-worn face.

"The blacks believe Sheko breathed death on the world and left her ghost to haunt it. Maybe she did, though that's hard to believe. Perhaps the myth reflects some great natural disaster. My father never knew what to think. He finally called Sheko's curse simply a metaphor for the evil in us all." She sighed. "It's hard to see any good future for my little boy."

It was hard for me to see any good future for us.

For exercise while we were there, I walked with Ram on a gravel path around the clearing, the little fort and Hake's palisade on one side of us and the jungle on the other. Giant trees with grotesquely buttressed roots towered to a dense green canopy that shadowed the trail. Through gaps on the wall of undergrowth, I caught glimpses of brilliant birds. Enormous orchids blazed with colors that carried scents that tempted me farther than I wanted to go. Now and then I heard an eerie scream

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from something I never saw.

One morning when we were on the path I head a cautious call form the jungle. Toron stepped out of the undergrowth to beckon and stepped back again. The fright-mask was gone but he looked savage enough without it, with a bright red turban and a leather vest beaded with brilliant purple and orange. A wicked blade in a blue-beaded scabbard hung at his waste.

We followed him out of sight from anybody. He spoke to Ram, his voice so hushed and rapid that I caught very little of it. Ram kept repeating "Mish," the word for "no." Toron's lean black features hardened with anger until at last he drew his blade, slashed a hanging vine out of his path, and strode back into the jungle gloom.

"I don't like it!" Ram muttered. "I think he belongs to the corath cult, though he never said so. He says I was blessed with Anak before I was born, marked with the crown of worlds, and sent through the trilithon to liberate his people."

He shook his head, his face gone as hard and bleak as Toron's.

"Destiny I never asked for and trouble we don't need."

That night I dreamed Sheko's ghost had slipped into our room. She was skeleton-thin, her head a grinning skull, her deep-sunk eyes burning read as the hoppers' headlamps. Her bone-thin hand clutched a blade like Toron's, dripping Anak's blood.

A wisp of blue mist, shining in the dark, she came to lean over me. Her breath had the foul stink of the corath bloom. The glare of her eyes felt hot, yet I shivered from her deadly chill. Her bare teeth moved as if with speech, but I head no sound. She left me in a moment and glided on to Ram.

In the blue of her body I saw him sit up in his bed, blinking at her. Her skeleton arms reached to embrace him. I head him yelling "Mish! Mish!" He held her off until she offered him a steaming cup of corath tea. He gulped it down. I heard a piercing shriek. She flickered and vanished, but her evil odor lingered in the air, so powerful that it woke me.

I was alone in the room.

16.

The silence hit me first. We had snuffed the candle out when we went to bed—Hake's Landing had no electric lights. I called Ram's name and got no answer. I stopped breathing to listen and heard no sound at all. I groped through the darkness to feel for him and found the empty bed already cold.

With no idea what had happened or what to do, I stumbled back to my own bed and lay there through the hours of another nightmare. Ram had been a strong companion and the best friend I'd ever had. Feeling helpless without him and paralyzed with fear for both of us, I could expect no help from Hake or the agent. All I could do was lie there in the dark, hoping he would come back safe.

Daylight broke at last. The black maid came in with a pitcher of hot water and a tray of ripe fruit. Seeming astonished by Ram's absence, she ran out to report it. Lela Lu came back with two mulatto officers who battered me with questions I seldom understood. They kept an air of distant respect that failed to hide a watchful hostility.

The room had a single outside window with a wooden shutter but no glass. We had left the shutter open for ventilation. They examined the window and found blood smeared on the splinters. Ram, I thought, must have been gagged or knocked out and dragged though the window, but I felt too uncertain of anything to tell them about our encounter with Toron in the jungle.

Lela Lu called me for breakfast after they were gone. I had no appetite.

"Eat," she told me. "You're going to need your strength."

"I'm sorry about your friend." Kenleth

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eyed me anxiously when I came out to the family table. "I'm afraid for you."

I ate a slice of toast and a few bites of a ripe papaya, and drank a cup of tea sweetened with a little cake of hard brown sugar. Hake came late to the table, with no more appetite than mine.

"An ugly thing." He rapped his cup on the table and waited for Lela Lu to refill it. "I don't care who Ty Chenji is or where you came from. Ty Toron and his men have inflamed the slaves with their tales about him. They believe you two have come through the gate to set them free."

He gave me a searching scowl.

"Do you know where Ty Chenji went?"

"Mish," was all I could say.

Lela Lu was offering us a plate of fried plantains.

"I'm afraid of insurrection." Impatiently he waved her away. "I had two guards on duty last night, men I trusted. This morning they're gone. You saw that hook in the tree at the agency? Last night somebody cut it off the rope and took it away. A gesture I don't like."

Neither did I.

I was pacing the floor like a prisoner in my room when Lela Lu came to the door to tell me that the agent wanted to see me. His office in the fort was almost a museum of native art. Bright-woven rugs covered the floor, grotesque wood-carvings stood along the walls, his desk was cluttered with strange ceramic figurines that must have come from looted tombs.

The black guards let me in. Seated at the desk, he squinted shrewdly at me through dark-rimmed glasses and spoke to his black mistress. She sat close beside him, nursing the brown baby at an ample breast. The language we had been learning was a lingua franca created by Norlan traders. They must have been using her tribal tongue. I got nothing of what they said.

"Ty!" He stressed the honorific, perhaps in mockery. "We've all heard your unlikely story. Have you anything to tell me about the disappearance of Ty Chenji?"

"Nothing," I said. "Mr. Chenji wants to make no trouble for anybody. We do come from another world. We left it through an old stone gate we found in a desert there. We've been wandering since, looking for a way back home. That's all we want."

"Perhaps." He squinted at me sharply. "How did Ty Chenji get that mark on his face?"

"He was born with it. He doesn't claim to be the heir to any god. He certainly had no purpose to make trouble here."

"Purpose or not, he's made it." He dropped his voice to confer with the woman, and finally swung back to frown at me. "Ty, whatever he is, his absence leaves you in an awkward situation. If he involves himself in any slave unrest—"

The woman spoke, her voice sharply lifted. The baby was rooting for the other black breast. He smiled at them and turned back to frown at me.

"I don't know who you are, Ty White, but if you have any reason to ask me for help, you'd better speak now."

She adjusted the baby and they waited for me to speak.

"I do need help," I said. "So does Ram Chenji. He was taken out of our room last night. There is evidence of a struggle. That's all I know. I'm afraid for him."

"You ought to be." The agent sat a moment with his troubled eyes on the nursing baby. Very soberly, he turned to me again. "You ought to understand that your association with him could get you charged with treason."

Helpless, I could only gulp at a cold knot in my stomach and try to thank him for the warning.

"You are sure you have no more to tell me."

I shook my head.

"That was your chance." He turned severe. "Perhaps your last. The black po-

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lice on duty last night looted the arsenal and deserted en masse. They took side arms, muskets, ammunition, and grenades. I don't know what to expect." He made a grim face. "Except more trouble from your friend Chenji, whoever he is."

The woman spoke and he nodded.

"Ty White, you will remain here at the landing under house arrest. You will not leave the palisade without my permission."

That was no problem. I had nowhere to go.

I've always been more spectator than actor. I try to blame my nature on an accident that I barely recall. My mother was arranging a surprise party at a neighbor's house for me on my third birthday. My father was driving me there when another car came through a stop sign and struck us.

My father died. I spent several weeks in the hospital and had to learn to walk again. I still have a bad knee, and I envy such men of action as Ram and Derek. I used to enjoy our low-limit poker nights as safe adventures, but sometimes I had to wonder how I'd been able to nerve myself to come with then to Africa. Now I knew nothing to do except wait for some decision by the high commission down the river in Periclaw and hope for good news of Ram.

Back in the compound, the trader's wife asked me to biscuits and tea in the library room where she kept what she could of her life in civilization: a few books, framed pictures of her family and the home she had lost, a tall harp she had tried to teach Kenleth to play.

She wore a scarf over her untidy hair and her face was tight with trouble.

"The agent and his woman!" She shook her head. "How did it go?"

I told her about the house arrest.

"You worry Ty Hake." She frowned. "But I want you to know you're welcome here as long as you can stay."

I tried to thank her, and asked what she expected.

"I don't know." She sat with Kenleth close beside her, her arm around him as if to shield him from the crisis. "It's a bad time. Our living here depends on trade with the blacks. We try to get on. Maybe some of them like us. Most of them don't."

A wide window that had no glass was open to the heavy scents of the jungle. Some wild thing shrieked out in the thick green canopy that hung so near the palisade. I thought she shuddered.

"I long for Periclaw." Absently, she was smoothing Kenleth' hair. "Life seemed good. But here—" Her thin shoulders hunched. "We live on the edge of a black sea that can rise up and drown us."

I asked what she knew about the corath cult.

"Not much." She shrugged. "The Elderhood. A secret society of the blacks. My father thought it might date back to the old empire. They're said to use corath to induce mystic visions. They think they own the jungle, and they don't like us in it."

Far away, something was screaming again, and she listened in silence.

"I used to sit in my father's class on the conquest of Hotlan." Her tone turned ironic. "A misnomer. There was no conquest and nothing to conquer. The blacks live in a thousand isolated tribes, with only trails between them. No vehicles or roads fit for them. No domestic animals.

"The tribes are independent and often at war, but my father thought the brotherhood was a sort of shadow government, trying to unite them with the secret rites of Anak and fighting the Norlaners with a secret army. Maybe that's true.

"The corath trees are sacred to the blacks, planted by Anak himself, the seed used only in their ceremonial rights. Its abuse by the whites is a sacrilege, but my father thought the brother-

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hood had made it a weapon, selling it to corrupt and destroy us.

"I don't know." She sighed and drew Kenleth closer. "A bad time, with worse to come. The river is rising, my husband says, and the levy leaking. His business is in danger. Maybe our lives."

I tried to talk to the trader when I saw him at noon. He laughed at his wife's apprehension.

"She's sick with fear for herself and the kid," he said me, "but I've survived hard times before. I told her not to fret. The agent expects a few more regulars on the next upriver packet. Enough to hold the fort. And we've got nothing here worth a fight. If trouble comes, it will be farther down the river."

Yet her fears were hard to forget. Too restless to stay inside the palisade, I took uneasy walks along that path between the clearing and jungle, hoping in spite of common sense that Ram would step back out of it as suddenly as Toron had done. He never did.

The storm broke one morning at dawn. A crash like thunder woke me. Some kind of bomb had come over the stakes. I heard men yelling. Smoke stung my eyes when I looked out the window. Yellow flame crackled in the palm-leaf thatch of the corath mill. Warriors waving long jungle knives came swarming into the palisade.

17.

Kenleth darted into the room.

"Ty, quick!" He tugged at my arm. "Mama says we've got to run."

I pulled on my pants and boots, grabbed my backpack, and followed him to the front door. The trader and his wife stood there, his jaw clamped hard on a narcotic wax he chewed, a long-barreled handgun swung at his hip.

"Get to the fort!" he shouted at her. "I'll save what I can."

"Mish!" White and trembling, she clutched his arm. "I can't—I won't leave you to face them alone."

"Think of the kid." He shook her off. "He'll need you."

"Come! Please! They'll kill you."

"Maybe not. I've handled trouble." Tears shone in his hollowed eyes. He brushed at them and reached to draw the gun. "Save yourself. Save the kid."

She hugged him for a moment, kissed his lean cheek, and we ran. Behind us, scores of blacks danced around the blazing corath mill. Black half-naked bodies smeared with yellow tiger-stripes, they were screeching out a tuneless song.

I heard a gunshot and looked back again, but nobody followed. We found scores of frightened blacks milling around the gate to the fort, clamoring for safety. The agent's black mistress stood there, two mulatto guards behind her, turning most of them away. She met us with a tight-lipped scowl, but our skins were white. She had to let us in.

Inside the high brick wall, we found something close to panic. A mulatto in uniform was trying to drill a few black volunteers the agent had enlisted. A gun crew was loading the brass cannon on the roof. The agent was pale and sweating, shrilling jittery commands. He shouted an order I didn't understand, and the guards hustled me into a concrete cell.

I was there for several days, the worst I had ever known, without much hope of anything better. Alone, I had no contact with anybody who wanted to talk. I longed for news of Lupe and Derek and Ram and felt sick with fear for them. All three lost amid hazards I couldn't imagine, perhaps no longer alive.

With none of Derek's quiet detachment or Ram's ready competence, I found few resources of my own. The cell had only a bare concrete shelf for a bed and a foul hole in the floor for a toilet. The food was tough and tasteless little slabs of something I never recognized. I paced the narrow floor for exercise, and spent hours staring at strange little lizards that crawled the walls.

I had one brief break, when my jailers

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let the trader and his family visit. Hake was limping on a crutch, his head covered with a bandage that hid one eye. His wife looked ill and exhausted. Kenleth hugged me silently, his little body quivering with sobs. The guards stood watching from the door as if ready for some attempt to set me free.

I asked for news of Ram, news of anything.

"Nothing—" Lele Lu's voice quivered and broke. "Nothing good. The wild blacks were crazy. Stoned on raw corath. They took everything we had. Burned us down. Ruined us."

"We are down." A long red scar ran down the trader's cheek, but he tried to smile at her. "I've been down before. I'll get us up again."

"They were about—" Lela Lu shivered and shrank from the guards. "About to chop his head off, till Toron told them Mr. Chenji had been our guest. They think he came to save the world."

"I'm afraid they expect too much."

"They worship him. He's the son of Anak. His touch is pure magic. He can open the eyes of the blind, restore missing limbs, and breathe new life into the dead."

Hake made a sardonic face. "They've never seen him do it."

"I'm sorry for you." Kenleth caught my hand. "I begged the agent. He says he can't do anything."

"Not that he gives a spit." Hake shrugged. "He's getting off his hot spot. Transferring to a frontier station far up river, next to the free tribes. Waiting now for his replacement. And happy to have you out of his hair."

"They're taking you down the river," Kenleth said. "I don't know what they'll do with your there. I wish we could go with you."

He looked at his mother with a silent appeal.

"I told you why we can't." She shook her head, a shadow on her hollowed face. "Periclaw would be worse than the jungle."

The jailers rattled the bars, and they had to go. Hake advised me curtly to watch my step. Lela Lu kissed my cheek. Kenleth gripped my hand with both of his and tried not to sob.

"I'm afraid, Ty Will." He swallowed hard and shook his head. "Afraid I'll never see you again."

So was I. I caught him to me and held him close till the jailer shouted for him to go.

The new agent, a burly blunt-spoken veteran of the river patrol, arrived with a little detachment of native troops. He had me brought out of the cell to his office. Stripped of all those native artifacts, it was now severely bare, the desktop empty of anything except a sheaf of orders. He glanced at me and then at a clipboard. A chair stood empty in front of the desk but he left me standing, facing his searching scowl.

"You call yourself Will White?"

"That's my name."

"If you're really white—" He grinned at his own amusement. "What are you doing with this black witch doctor?"

"Ram Chenji is my friend."

"You've made the wrong friend."

I tried to tell our story, but he was impatient with my halting language.

"That's enough." He cut me off and beckoned the guard to take me out. "You're on your way to Periclaw. You can try your tales on the high commission."

Yet the agent never sent me back to prison. Perhaps the agent's wife persuaded him to hear our story. Perhaps he wanted it simply for his reports to Periclaw. Still with no sign of belief, he had a sudden willingness to listen to our adventures on those other worlds beyond the trilithon on Mt. Anak. I was installed in a decent room and allowed to join his staff at decent meals.

Bound upriver, the former agent was leaving his black mistress behind. I was on the dock when a packet docked to pick him up. Outraged and screaming at

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him, she thrust the squalling baby at his face. He stalked away. She followed, pleading. He shook her off. She drew a dirk and struggled with the guards until they dragged her and the baby away to the jail.

Though the new agent had only a dozen men, he lined them up for inspection as if they had been a company and assured the refugees camped on the dock that they had nothing to fear from the rebels.

"No organization," he told me. "No discipline. No leadership." He made a derisive shrug. "Your black friend, son of a god or just another con artist, he's leading the fools to the slaughterhouse."

Born in Periclaw, son of a wealth plantation owner, he had the same contempt for the Norlaners on the ruling high commission.

"White-bellied spiders, fat on the blood they suck out of us! Sky-high excise taxes on river trade. Sky-high duties on every bale of cotton we ship north and every ounce of anything we have to buy. They're bleeding us dead."

The high commission acted at last. A gunboat arrived with supplies for the station and orders to rush me down the river. Half a dozen refugee families were waiting on the dock, hoping to escape with whatever they had been able to salvage from their abandoned homes, but the little boat had no space for them.

The crew was tiny. The mulatto engineer and black firemen had double duty as gunners at the long cannon on the foredeck. The captain was a white Norlaner, a loud angular man with a thick black moustache. Just out of military training, he was inflated with his new authority and proud to be white in a world of blacks.

He had no time for me, no interest in my story. The pilot was a better companion, an affable little man who called himself White Water Kel, so dark I though he had black blood. He listened to all I had to say about Earth and the trilithons, and liked to talk about the river and himself.

"Water's high," he told me. "Monsoon rains upstream."

The river ran fast where we were, a wide brown flood that lay flat from bank to tree-walled bank. Only a few hours out, we overtook a floating log. A human figure stood balanced on it, waving a broken branch. As we came near, I recognized Kenleth. I begged the pilot to pick him up. He was willing but the captain balked.

"Let the beggar swim. We've got ten thousand like him waiting on the banks."

I kicked my sandals off as we passed by, dived off the rail, and swam to the log. No act of heroism. The water was warm and I'd spent my high school summers as a lifeguard at the municipal pool. Kenleth grinned, dropped his branch, and helped me climb on the log.

The captain yelled lurid curses at me, words I hadn't learned, but he stopped the engine and launched a small boat to pick us up. Kenleth thanked my shyly and said he was starving. I got the cook to bring him a banana and a broiled fish left from breakfast. He devoured them and talked.

"A bad time," he said. "The raiders broke through the fence and got in the house. They took everything. The food off the table and my mother's books and my father's guns. I was afraid. I hid in the cellar. They burned the house over me.

"The air got hot and smoke got strong. I was trapped there a long time, afraid the roof would fall in. It didn't, but I was still caught there in the dark. I tried to get out when things got quiet, but some had fallen on the door. I couldn't get out till I found a tunnel that took me to the well.

"The raiders and my folks were gone when I climbed out. They never took the fort. The flag was still there and I heard the cannon boom, but the new agent called me a mongrel pup when I

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begged him to help me. All I could do was follow the raiders and try to find my mother again.

"The raiders took a trail back into the forest where we used to go to look for nuts and fruit. I followed all day and the next, with nothing to eat. I was afraid of snakes and crocodiles and jungle fevers, but I went on till I couldn't find the trail any farther. I was lost and hungry.

"All I could to was wander on and sleep at nights on the ground. Finally I came to the river and water I could drink. That log came drifting past. I swam out and climbed on it." He caught my hand. "I thank you, Ty Will. You saved my life."

I gulped and put my arm around him.

"I've lost my mother and Ty Hake." Anxiously, he peered into my face.

"Please, can I stay with you?"

It took me a minute to answer. Something about him brought back dreams of my own that had faded long ago. My colleagues and my students had become my family. Feeling as lost and helpless as he was, I was in no position to care for anybody. The responsibility seemed overwhelming. I had to get my breath.

"Okay," I told him. "If you want to take your chances with me.

He blinked at me through tears his eyes.

"Thank you, Ty Will!"

18.

Next morning we needed to refuel. White Water followed the channel markers to a pier built of unpeeled logs. The Norlan flag flew from a pole over a rough wooden shelter. I saw stacks of firewood ready, but the place seemed abandoned. The men tied us up beside the pier and began pitching chunks of wood aboard. I heard a hail before they were done, and saw a long dugout coming around the bend above us. The paddlers brought it near. I recognized Toron in the bow, poling it closer. Ram stood behind him, waving a palm leaf.

"Will?" he shouted. "We heard you were on the way. We want to talk."

The captain called his men to the cannon. He found a megaphone and shouted a command for the dugout to stand clear. Toron stabbed his pole into the mud to stop it where it was. He was nearly naked, yellow tiger-strips around his torso. Ram looked just as strange, in a black beret pulled down to his eyes and a long robe dyed in a pattern of purple, green, and black. Yet he still carried the battered nylon backpack he had brought from home. He waved the palm leaf again.

"Toron's speaking for the rebels," he shouted. "They want to offer a truce."

"Black vermin!" the captain snarled. "What sort of truce do they expect?"

Ram beckoned Toron to bring the dugout closer. The captain raised the megaphone. "Keep away, or we'll blow you out of the water."

"I know him," I told the captain. "He's a friend of mine. We came here together from my own world. The rebels captured him. Listen to him, please."

The captain shook his head, with a skeptical scowl at me.

"Tell him I know the rebels," Ram shouted. "Toron's speaking for them. We want to talk to the high commission, if he'll grant us safe passage to Periclaw."

"Hah" The captain sniffed. "I have no authority to offer safe passage to anybody."

"Maybe so," White Water said. "But let's hear them talk."

"Barter with those black vermin? The high commission would laugh."

"Maybe not," White Water insisted. "These men are risking their lives to talk. The intelligence service ought to be interested in what they have to say."

The captain scowled and let them tie up at the dock. White Water had the gangplank lowered. The engineer went down to search Ram and Toron for weapons. Ram laid down his jungle knife. Toron refused to leave his ancient blade. They left him on the dock, but Ram was allowed to climb aboard.

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He embraced me.

"A long haul back to Portales! A lot has happened since I saw you."

He offered his hand to the captain.

"Good of you, sir. If you can take us down to Periclaw—"

The captain ignored his hand and had White Water pat him down and search his pack for weapons. He swung to me. "You say you know this man?"

"We came here together," I said. "Through those old stone pillars on Mount Anak. You've heard our story."

The captain grunted and swung to Ram.

"What's your business with the high commission?"

"Peace," Ram said.. "An offer of peace."

The captain bristled. "We'll have peace when these jungle apes come to their senses."

Yet he huddled with White Water and let us into his cabin. We sat around a little table, the engineer ready with his gun behind us. Silently waiting, the captain glared at us.

"Believe me, sir," Ram begged him. "I know the rebels. They're fighting to take the river back and throw you whites off the continent. No real good for them. Disaster for Norlan. We want to offer something better."

The captain sniffed.

"Like what?" White Water asked.

"If you care to hear it, sir." The captain kept a stony face, and Ram turned to White Water. "Toron's an envoy from the elders of the corath brotherhood. Not a government, exactly, but it's the organization behind the rebellion." He nodded at the captain. "A force Periclaw ought to respect. They have the gunboats, but the elders have the jungle."

"Bluff enough!" the captain muttered. "What do they want?"

"Respect, sir. Recognition of the brotherhood as a sovereign nation. Liberation for its slave citizens. Fair pay for labor. Free trade on the river. Tax-free exports to Norlan."

"That's all the want?" The captain scowled. "What they get will be the hook through their ribs."

"Listen, sir. The deal they want will be good for them but better for Periclaw. They offer you peace. Security for your colony on the delta and your traffic on the river. Untaxed export of the food and fuel you need in Norlan. Isn't that enough?"

The captain grunted scornfully.

"Look at the alternative," Ram urged him. "I've met the native historians."

"Historians? Black animals that can't read or write?"

"They're learning," Ram said. "They're here on the ground. They study what they find the ruins of the lost empire. I brought an artifact I think should help us persuade the high commission. Would you like to see it, sir?"

"Jungle junk!" the captain snorted. "They peddle it to tourists."

"Give them a chance," White Water urged. "Intelligence might like to see it."

The captain shrugged and let Ram open his backpack. He dug out a thin little box like the one Derek found in the room where he slept on the planet of the robots. The captain shrank away as if it had been a viper.

"It doesn't bite." Ram turned to White Water. "I'm told that it came out of a sealed vault under a ruined temple of Sheko. The natives are terrified by a legend that she breathed death on the place. A white explorer dug it out. His porters stole it. Three of them died of a nasty jungle rot."

The captain blinked uneasily, his hand near his gun.

"I've heard the story." White Water picked up the object, frowned at it, passed it back to Ram. "What is it?"

"Take a look."

Ram lifted the lid. A rainbow of colors lit an array of symbols. Sound pealed out of it, deep notes that throbbed to a rhythmic beat at, lifted to a melancholy wail, and slowly died away. The symbols faded into darkness. Stars appeared, and

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the silver dust of the Milky Way. Bright constellations swam across the screen. One star grew. A planet in orbit around it swelled to show seas and continents.

"Africa!" Ram whispered to me. "They've been there."

I saw the shape of it, then a green plain edged with volcanic cones. It spread wide. I saw animals: wildebeest, antelope, ostriches, and elephants. They raised their head, froze, scattered in panic from a rocket ship descending on a cushion of fire. The rocket dissolved into a tall black trilithon. Strange machines crawled out of it, and then a file of dark-skinned men and women.

"That's us," Ram said. "A couple hundred thousand years ago, arriving from wherever we were born."

They vanished, and I saw a single human figure standing alone on a bare mountaintop. An aged black, scarred and bent, leaning on a cane. He spoke in a strange high voice, trilling syllables I had never heard. That uncanny music rolled again, and his voice gave way to a page of the symbols we had seen on the monuments of other worlds.

Ram touched a key. The screen went black. He closed the box.

"What's that?" the captain muttered.

"A book," Ram said. "And maybe a computer, if we knew how to work it. The elders have recovered several of them. They can't decipher the text. Not yet, but the images are enough to reveal something about the civilization that left all the ruins in the jungle. They take this for a history of the Grand Dominion. That's their name for the lost empire."

"So what?"

"If you will grant us safe passage, we want to show this to Periclaw. I think it will help persuade the high commission to talk."

"Not likely!"

"Sir, they should. The Grand Dominion is dead. Something killed it. I don't know what. Neither do the elders, but they have scholars working to recover its lost science."

"Scholars? When they can't read or write."

"They're learning." Ram pushed the book across the table. "Periclaw should give them a hearing. If you'll give us a safe conduct—"

"To that black bastard? I'd hang him first."

"If you feel that way," Ram said, "I'll go alone."

"If you're that kind of fool." The captain shrugged and squinted at the box. "Just get that infernal machine out of my cabin."

Ram went down to huddle with Toron and his men. They climbed back into the dugout and pushed it away. Ram stood watching until it was gone beyond the bend.

"To pay my way."

He took off his robe to sweat with the crew, loading the rest of the firewood. We steamed on again when that was done, down the mud-colored Blood. He shared the cabin with Kenleth and me. I wanted to hear about where he had been, but he was slow to talk.

"Later," he said, and shook his head. "Too much has happened since I saw you. Too much you'd never believe." He stood silent for a time, gazing into the jungle behind us. "I need Lupe to help me decide what I am."

He slept most of the afternoon and woke with a haunted face.

"What a dream!" He grimaced and blinked at me. "At first I thought we were back at home at one of our poker nights. Lupe was about to serve her guacamole salad, but then she was Little Mama, reading the script in that artifact. It was a message from Derek and Lupe. They were lost in a stranger world than this, hiding from the hoppers. And then—"

His shoulders hunched uneasily.

"It's all too much. Too much that gets me down." He sat rubbing his eyes as if still half asleep. "I learned my science from Derek and Lupe. It's meant to

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make life simple. Nice clean answers to everything. But my life was never that simple."

We anchored before sunset in the shallows off a sandbar, where we were out of the current. The engineer dropped a hook over the rail and pulled up a magnificent silver-colored fish that he grilled for dinner. The fireman found papayas ripe in a field on the bank.

I recall that meal as an unexpected moment of pleasure. The fish and fruit were excellent. The captain sat watching Ram with silent suspicion, but White Water opened a bottle of very good wine to play the jovial host. Ram laughed at his tall tales of life on the river as if all his problems had been forgotten.

Night had fallen before we got back to the cabin. While I was fumbling in the dark for a match to light a candle, Ram closed the door and took off his cap. Light filled the room. When he looked at me, I saw that it came from his birthmark, shining like something incandescent.

19.

The anchored ship was soundless that night, except for the muffled thump of the watchman's boots on the deck and the far-off howl of some jungle thing we never saw. I sat down on my berth, staring in amazement as Ram lifted his wrist to read his watch by the glow from his forehead.

"The crown of worlds?" I felt almost afraid to speak. "I always wondered. Did it ever shine before?"

"Never."

The mark shone brighter when he raised his head to look at me, but he was silent till I asked, "You say things have happened to you?"

"A long story. I've been initiated into the corath brotherhood." He paused, and his voice had fallen when he spoke again. "Things I don't understand. I almost hate to tell you. I don't want to make a stranger of you."

"No danger. Just tell me."

"I'll try." He nodded soberly. "If you won't call me crazy."

Lying on his berth in the hot and silent cabin, he began to talk.

"It was Toron who got me out of Hake's compound. He'd seen the mark, of course, but he took it for a tattoo. Took me for one more ambitious pretender to the legacy of Anak. It wasn't shining then, but he thought he could use me as a figurehead leader for the revolt. I've lived a sort of epic in the jungle since."

A steamy breath of it came through the window, a thin sharp scent of strange blooms and strange decay. I felt grateful for its cool feel on my naked skin. Kenleth lay snoring softly on the floor.

"The whites dread the jungle, but it s a loving mother to the blacks. Feeds them, shelters them, hides them from the slavers. Derek and Lupe would give their skins for a chance at their culture and their history. I've tried to pick up what I could.

"Hotlan's huge, bigger than Africa. Hake's wife showed me a map of it. The coasts have been well explored, and the navigable channels of Blood River. The mountain chain on the west coast is higher than the Himalayas. There's a second Sahara across the north and a vast stretch of the south still blank on the map.

"The Blood drains half the continent. Most of it's jungle, unknown to the whites but home to the blacks. Hundreds, maybe thousands, of tribes. You'd call them savages. No writing, no printing, no metals except scraps they salvage. They've got no government, no organization, no cities, and no common language.

"Yet they're children of the civilization that opened the gates and got them here. How they lost it the sort of riddle that Lupe loves to solve. She'd find clues

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everywhere, beginning with the corath elderhood. They worship the little they remember and dream of restoring the great past they've lost.

"That's what Toron's fighting for, his chance to beat the Norlaners and liberate the slaves. The blacks are nomads, following the creatures they hunt or the seasons when food plants are ripening, but Toron took me to a permanent center.

"A strange experience—"

Kenleth cried out in his sleep. Ram sat up to look. In the glow of the birthmark, I saw the boy twist and beat at the air for a moment, until he relaxed and lay back with his head of his arm, a slight smile on his lips. I was growing fond of him and worried about his future, half black and half white in this world of bitter race division.

Outside, a long-drawn wail quavered and died. Something answered from farther away. Ram must have seen me shrink.

"Unearthly." The mark lit his grin. "This isn't Earth, but it helps to remember that all its life originated there. Derek's idea, confirmed by what I've seen. Both life streams changed, of course, by a hundred thousand years of evolution. A lot of it here is hard to recognize. I've seen things that I hope never lived on Earth. One of them—"

He frowned and shook his head, staring into the dark beyond the open window. Far across the black river something shrieked and shrieked again. His grin was gone. He rubbed at the shining mark as if it hurt or somehow troubled him.

"I'd set out with Toron on a trek to the site for my initiation. A man I wanted to like. I admired him for his courage and his stoicism in the face of pain. He seemed dedicated to the liberation and future of his people, but I knew that he had been a slaver. He was generous and helpful to me, yet I knew he saw me as a tool that might serve his own grand plans.

"We went north from the Blood in a dugout with half a dozen warriors at the paddles. One carried a captured army rifle. The others had two or three handguns or native weapons. For long days we rowed or poled up tributaries that narrowed into gloomy green tunnels and ended finally at the foot of a rocky escarpment, where we had to leave the boat. We climbed that to a trail choked with undergrowth so thick that only Toron could follow it.

"Back at home I had an excellent sense of direction, a sort of compass in my head, but on this planet—" He frowned again and shook his head, the glow of the birthmark dancing over the walls. "Here it's gone. I felt lost without it, lost and helpless.

"The trail was hard to follow, but Toron knew the way. The going became difficult, a tangle of vines as thick as ropes, undergrowth so dense we had to slash our way with jungle knives. We waded rivers and slogged through swamps. There were trees and creatures I knew, but more I didn't.

"One day I caught a scent—"

He seemed to shudder, the light of the birthmark flickering over the room.

"It turned me sick. A heavy, fetid sweetness that had a carrion taint. Toron held his nose and pointed off the trail.

"'*Slubro-slubrok,*' he said. That translates as gut-worm, though it was a plant. He said Sheko's angel of death had breathed on the seed. She sowed them to guard her tomb, and Anak's. It stood ahead of us at the end of the trail. I wanted to see it.

"Toron wasn't eager. He said he'd been there, as a guide for a white named Carno Fen, who was a friend of the blacks. He'd made a fortune with a ship line and a chain of trading posts on the river and spent most of it building schools and hospitals for us. He wanted to join the elderhood, and the elders agreed to honor him with an initiation.

"Toron warned him of ugly spots in the jungle, places still contaminated, I

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imagine, with lethal agents left from that ancient Armageddon. He was older than you are, Toron said, but still vigorous enough. When he heard about the *Slubro-slubrok*, he had to have a photo for his journal of the expedition.

"A madman, as Toron tells the story. He had a breathing mask that let him stand the odor. He bribed Toron to go on with him. The jungle thinned. They came though a stand of dwarfed and twisted plants, into a clearing where the rocky ground was littered with the bones of things that had died there.

"Toron kept away from the *Slubro-slubrok,* but Fen took pictures and Toron got back with his camera. An ugly thing, he said. Its leaves were huge and black, thick as mattresses, scattered with long yellow spines. They lay flat for yards on the rocky ground. A single enormous bloom, purple and trumpet-shaped, crowned a central stalk.

"Fen's mask didn't save him. Toron saw him stagger and tried to call him back, but he went closer for another picture. Toron heard a pop. Something sailed out of the bloom and fell near Fen. A seed, Toron said. He has Fen's picture. It's purple-black, about the size of a plum.

"Toron was sick with the stink of it. Fen was drunk on it, or somehow overcome. Toron says picked it up, sniffed it, bit into it for a taste, swallowed it whole, and staggered back to Toron. He soon seemed to be himself again. Toron found the trail again and they went on.

"The next day he complained of an ache in his gut. That grew worse. He lost strength until he had to be carried on a stretcher. The pain was so severe he begged Toron to kill him. On the last night he crawled away from the tent to relieve himself and never came back. Toron searched for him when day came, and finally found what was left."

Ram stopped and looked at me with an expression I had never seen. I thought the birthmark had dimmed. Far off across the river I heard a long-drawn wail that might have been Fen's ghost. A breath of air from the window seemed to have a taint of death.

"I don't know," he muttered at last. "Derek was convinced that all the life here came from Earth. I know evolutionary jumps are facilitated by small gene pools and changed on survival, but Toron showed me the shots he salvaged from Fen's camera. It's hard to believe that thing can exist."

"The *Slubro-slubrok*—"

He paused again, and shook his head.

"All Toron found of Fen was his empty skin. The film shows it lying flat in a puddle of bloody excrement. The flesh is gone, the bones, the skull. Toron says he stood there a long time staring at it, till he thought to keep a record and started back to the tent for the camera. The moment he moved, he heard an uncanny sound.

"A shrill cackle, he says, like nothing he ever heard before, but somehow like a human laugh. It came out of the stunted stuff around the clearing. He looked and saw the snake. A monstrous thing, he says, the sleek black coils of it half hidden in the undergrowth, its lifted head as tall as a man.

"The head was shaped like Fen's skull."

Ram shook his head at me, and the glow of the birthmark dimmed for a moment.

"Toron showed me the film and tried to describe it. He says it stared at him for a minute or two. Its eyes were huge. They never blinked. Fen had worn glasses. Toron swears those eyes were shaped like the lenses. He was trying to steady his hand for another shot when it cackled again, and slithered out of sight."

20.

"The *Slubro-slubrok*—" Ram sat staring at me, shaking his head, the glow of the birthmark flickering across the wall. "If the Old Ones were genetic engineers, they created a nightmare. Maybe

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to guard forbidden spots. I wish I'd never seen it."

He shrugged and raised his hand to hide the light as the watchman's boots came thumping by. The tiny cabin was silent except for the murmur of the current against the hull, and sometimes the cry of some far-off jungle thing.

"It's another world," he muttered as the boots receded. "Kin to ours, I know, but still we don't belong. I don't think we ever will, even if we're stuck here till we die. I think we are."

"Maybe not." I tried to cheer him. "If we ever find Derek and Lupe—"

"Don't count on it." His voice was short. "I don't expect them—"

He caught himself.

"But we can't let it get us down." His grim face relaxed, and the crown lit an easy-seeming grin. "Here we are. Maybe in Little Mama's hell. Maybe at the gate to her heaven, if she had a heaven. We've got to make the best of any breaks we get."

"About the corath Elderhood?" I prompted him. "And your initiation?"

His voice grew more sober.

"Toron warned me that Sheko had laid her curse on the land ahead, but I let him lead us on. The lush jungle stuff gave way to a harsher sort of country. The trail spread wider, winding though gnarled and stunted trees. Sometimes it followed a scrap of ancient pavement. We passed a tall black granite stele, the inscriptions eroded away, and crossed a deep ravine on a dry viaduct that once carried water to a field of stony mounds that once had been a city.

"Relics of the Grand Dominion, Toron said. It was a rich and happy land, he said, until the sad day that Sheko found Anak with a human woman. In her rage she tore stars from the sky to hurl at them, and breathed death on him and all the women he had dared to love.

"Yet that vengeance gave her no joy. Mad with grief for the love she had lost, she rebuilt the stones of his palace into a tomb for him and sowed the seed of the *Slubro-slubrok* to guard it from his bastard half-human sons. When that was done, she built her own tomb and lay in it to die of sorrow."

Ram made a quizzical face.

"Toron's story. Sheer nonsense to me. Lupe says such legends have nearly always grown out of some actual event, but it's hard to imagine any kernel of truth—"

He stopped to listen to a faint and distant banshee wail.

"Sometimes I wonder about Sheko and her breath of death. As we went on, we kept on stumbling on signs of some blight I never understood. The blasted vegetation gave way to stark desolation. The sun seemed hotter. A few high clouds gave no rain. We sweated on across naked rock and dunes of drifted dust.

"Death's dark domain." He gave me a wry little grin. "That was my pet phrase for it. A dead gray waste. No life anywhere. It got to me. Dead stone. Dead sand. Dead silence. No birds sang. Nothing moved, not even a lizard. It left me wondering what killed the Grand Dominion.

"We ourselves were close to death, but Toron tramped on till I thought he was mad. My feet were blistered. Our food was gone, the last water canteen half empty. I thought we ought to turn back and asked Toron if we had gone too far for that.

"'No go back.' He was learning English. 'We get there.'

"I asked him where.

"'Place of life," he said. 'Place of wisdom. Cave of Elders.'

"Next day we saw a dark streak across the bleak horizon ahead, and then a faint green line below it. It rose as we neared it, a long escarpment of red sandstone. Next morning we reached another aqueduct. Half ruined, it still carried a thin stream of water from a spring at the foot of a cliff.

"Water! We'd been desperate for it.

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Toron and his men knelt to kiss the ground and give thanks to Anak. We buried our faces in the stream to drink, splashed each other to wash off all the sweat and grime. Following the aqueduct, we came to a field of growing corn, and then a row of ripe yellow melons as sweet as cantaloupes.

"Heaven!" He shrugged and laughed at himself. "I thought we'd crossed Little Mama's hell and reached her heaven. We stuffed ourselves with those melons and tramped on into that small paradise. I heard what sounded like a mockingbird singing. A man shouted at us from a mango tree. Ram called to him and he climbed down and came to meet us.

"An angel, I thought, in Little Mama's heaven. Or at least a saint. A tall black man in a neat green tunic and turban. His flowing beard was white with age, though he seemed spry as I was, carrying his basket of ripe mangos. They embraced, greeting each other in a language new to me.

"'Olec Ahn,' Toron said. 'Voice of Elders.'

"He shared his mangos and guided us along the cliffs to an overhang that sheltered the mouth of a limestone cave. He hammered a gong that brought a dozen men out of the fields and the cave.

"'Elders,' Toron said. 'Leaders of Elderhood.'

"They were an odd little group, all of them black, aged but fit, all of them uniformed in the green tunic and turban. They surrounded us, staring at me, calling questions to Toron in that tongue I'd never heard. We were still famished. At last, when the questions were answered, they set out a feast: dried meat, dried fruit, and hard dry bread.

"As we ate, I had questions of my own for Toron. He was slow to answer.

"'Place of secrets,' he said. 'Secrets kill you.'

"The Elders do have secrets that I have sworn to guard, but there are things I am free to say. The Elderhood is not a government; the blacks are scattered in hundreds of isolated nomadic bands. They want no government. The Council of the Elders is a little like a college, a little like a monastery, a little like a congress, but without visible power. It has only thirteen members, elected from thirteen secret cells scattered through the jungle.

"The Elders think of themselves as the last surviving vestige of the Grand Dominion. They've been trying to find and preserve relics of it, hoping for some kind of restoration and recovery. Toron sees a new promise in our arrival. There's the legend of a half-god, marked with the crown of worlds, returning through the Gate of Anak to restore the Grand Dominion. Toron saw us appear there. He's seen the mark.

"Yet he's a realist, a doubter of miracles. There have been known con men tattooed with the crown and proclaiming their own grand schemes. He first took me for another, but that didn't matter. He hoped to use me as a symbol to energize the slave rebellion.

"He took me to see the archives of the Elderhood and relics of the lost empire stored at the back into the cave. The Elders have no real writing system, but he showed me sheaves of little bamboo splints strung on cords and notched along the edges to record names and dates and facts.

"He showed me a shelf of e-books like the one he gave me, and a chest made of something still as bright as stainless steel. It was lined with gold and filled with little crystal rods. Magic sticks, he called them, their magic long forgotten. Transparent as glass, they flashed with colored lights and made musical notes when he rubbed them. Books or records, I imagine, that Lupe and Derek would give their eyeteeth to see.

"My initiation began the day after we arrived. We fasted that night. Drums woke me at daybreak. Seven of the Elders were out on the ledge under the overhang, shuffling around a huge cop-

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per kettle of boiling corath, chanting in cracked falsettos. The drummers paused at sunrise, but the chant went on. Olec Ahn came out of the cave to add a cup of brown powder that turned his brew the color of blood.

"He dipped out a cupful, held it toward the rising sun until the chant was ended, and gave it to the dancers. They passed it from lips to lip and back to him. He filled the cup for Toron and again for me. Scalding hot, it had a strange bitter taste. I took a gulp and passed it on."

He made a face.

"Back on Earth I'd tried half a dozen different drugs. They never hit me hard or made me want another shot. That red brew was different. It was slow to act, but the effect of it frightens me even now. The rites are secret, but there's a story I'd tell Lupe if I had a chance. A creation myth she would love. Toron translated it for me.

"All things were born from empty darkness. The first star shone alone until it bore the constellations. Each star burned alone until it bore its planets. They bore no life until the First World hatched worms from its dead sea mud. Those worms climbed into sunlight and evolved the Eternals, who were immortal.

"The Eternals bore Anak and Sheko, who sent robots to open the gates and search the universe for other minds. The robots found life on Earth and carried it to seed the sterile worlds. Anak and Sheko brought the human kind here, and nurtured the civilization that bloomed into the Grand Dominion.

"Unhappily, however, they had left their immortality left behind. They fell out. Sheko murdered Anak and died herself of grief. Without them, the Grand Dominion crumbled into a thousand ways of ruin and death. Its few survivors in the Elderhood are striving to find the life they can."

Ram paused, his dark face grave in the birthmark's glow, his head tipped as if to listen for those distant jungle sounds. All I heard was a distant splash, as if a fish had jumped in the river. He shrugged. I saw his dark grin, and his voice had fallen when he went on.

"Those words are Toron's, as I recall them. They seem dead when I say them now, but they carried a life and a fire of their own when I heard them chanted to the drumbeat as the dancers swayed around that copper pot. It may have been that blood-red brew, or only my own imagination, but I felt my mind expand in ways I can't describe.

"I shared the awe of the dancers when they saw those first constellations explode out of primal darkness. I felt Olec Ahn's wonder as he watched Anak's robots swarming to open the gates and bearing life to seed the new planets. I felt Toron's shiver of terror when Sheko breathed death upon the world.

"An unsettling experience." He shrugged again, and the birthmark lit a solemn frown. "I've always yearned for truth. I learned first from my Little Mama, who cared for me before I was old enough to care for her. She filled my head with what my father called silly superstition.

"His people had been devout Brahmans until exile and Africa made the American dollar their god. My mother was raised a Moslem. I learned to pray in a Christian missionary school. I came to America with no real faith. It was Lupe and Derek who taught me science, the method of asking nature herself for the truth. But that ritual—"

He shivered, the birthmark shimmering.

"The ritual went on till sunset. Olec Ahn gave us cup after cup of his bitter tea till the copper pot was empty. The drums are still beating in my head. The dancers shuffled on till they reeled and fell, chanting things I can't speak about. I found myself with them in the circle, joining in the chant as if I had always

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known it. I understood it then, or thought I did."

He shrugged, with a bleak grimace.

"We were sweating, limping, dead on our feet. Olen Ahn kept passing the cup to revive us, but one by one the dancers crumpled to the ground until only Toron and I were left. The sun was setting before he fell and left me alone. The drummers stopped. In my last recollection the world had changed around me.

"I stood alone under a dismal sky, black with smoke, tinged red with the fire of a great city burning on that empty desert we had crossed. I heard missiles shrieking overhead, gunfire rattling, great explosions thudding. Lurid flares floated out of the smoke. They lit great towers toppling, splendid domes crumbling into debris. I caught human voices screaming in agony and terror, faint and far away."

He sighed and shook his head.

"A dreadful thing. I'm afraid it really happened, though I don't know when or how I saw it. That was end of—of whatever that bitter drink did to me. I woke in a cold gray dawn, lying on the ledge beside the empty kettle, my body stiff and numb. The drums and the chant had ceased. All I could hear was some strange bird trilling. The first thing I felt was a sharp tingle in the birthmark. It became a stabbing pain that ached through all my body.

"I lay there till the rising sun warmed me and the pain faded away. The sun was high before I could sit up. I found the dancers sprawled all around me, seeming as dead as I'd been. A fire was crackling under the kettle, and Olec Ahn came with a cup of common tea, brewed from dried and roasted corath leaves. It revived me. One by one, the others groaned and moved.

"I think we'd all been dead." He blinked and shivered, frowning at me. "My brain had gone blank. Little Mama back in Mombassa, Lupe and her digs, the years at Eastern, even our Friday poker nights, all my life was blotted out. I lay there on the ledge the rest of the day, working to recover the life of my mind and my limbs. By sunset I could stand. The others were all awake. Olec Ahn gathered them around me. They squatted, open hands spread, and began a chant in that sacred tongue.

"Praying to me!"

He hesitated, eyeing me with a wary expression.

"The words were strange at first, but as dusk fell I began to understand."

He covered the birthmark with his hand let darkness fill the cabin.

"They were taking me for a god. The half-human son of Anak, born to liberate the land and lead the people out of slavery."

21.

"What am I?" The light from his forehead left most of Ram's face in shadow, giving him a haunted look. "A demigod, destined to liberate the continent? Or just a mad genetic freak?"

When I had no ready answer, he shrugged and his tone grew graver.

"I've never been sure who I am, or what I was meant to be. In my first recollections, Little Mama is rocking me on her knee, crooning her sagas of Anak and Sheko and the fall of the Grand Dominion in a language my father called a crazy babble. She told me I was a son of Anak, marked with the crown and born to rule the world in the sky where she was born.

"She believed the emerald pendant was a magic talisman that had guided her out of her own far world and through the Sahara Gate and on across Africa to meet the Portuguese exile who became my great-grandfather. My father laughed at that, but the magic was exciting as long as I believed it. Now I don't know what to think."

He lifted the pendant on its silver chain and sat a moment peering at it.

"Lupe and Derek have taught me a little science. Fireflies and deep-sea creatures have genes for luminescence that

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can be transposed into other genomes. I suppose a hereditary mark could be the work of some master geneticist, back in the age of the Grand Dominion. I'd like to know."

He shook his head and lay back on his berth. The birthmark lit the ceiling for a time, but it dimmed when he slept. I lay awake a long time, wondering with mingled hope and dread where the crown of worlds would take us. Dozing at last, I had mad dreams of millions of cellular robots pouring though the Stonehenge gate to conquer Earth. I felt grateful when the sun rose and I heard the steam whistle and the engine puffing.

We steamed on toward Periclaw. Kenleth dreaded the city. Next morning I found him leaning over the rail, staring into the wake. He started when I spoke.

"You frightened me." His eyes were dark and hollow. I saw dark tear streaks down his cheeks. "I was thinking of my mother. After what Mr. Chenji said, I'm afraid I'll never see her again. Afraid they'll kill me because my father was black."

White Water saw his mood and tried to cheer him up.

"Don't fret, kid. I've known blacks and whites and in-betweens. Some are good and some are rotten. The shade of color never matters. I can't tell the women apart in the dark. I see no justice in slavery and I hate to see the races at war."

He was young and he did cheer up. The voyage became high adventure for him. He made a friend of the mulatto engineer and learned how the engine worked. White Water let him blow the whistle when we approached s fuel station. The cook taught him to fish off the rail and broiled his catch for all of us.

Around bend after bend, the flooded Blood carried us on between dark jungle walls toward more omens of darkness. We met gunboats cruising up river and saw a big paddle wheeler aground on a sandbar, refugees waving to us from the deck. We passed a gunboat firing over a burning mansion at some target in the jungle beyond. The forests opened at last, on flat green fields that reached as far as we could see.

"The delta," White Water told us. "Worthless salt marshes once, rich plantations now."

When the channel took us near the bank I saw slaves at work. Men, women, little children, stooping in flooded fields to plant rice. Crawling with baskets to dig potatoes. Slashing with bright blades to cut sugar cane. Leaning in harness to pull wagons and carts and plows.

Once, far off, I saw bodies hung like black fruit in a solitary tree.

I found Ram leaning over the rail, staring up the river.

"It's run forever." A bleak look on his face, he turned to shake his head at me. "We didn't come here to make it flow the other way."

My eyebrows must have lifted.

"My Little Mama was born here." Ram spoke with sudden conviction. "She called it hell. She used to talk about a blood-colored river and her mother screaming in a tree. She found a little mirror to show me the birthmark and quoted her epics about my great destiny."

I had no idea what to say, but we were steaming on toward Periclaw. That afternoon we were standing with White Water at the wheel when he gestured at the flat green horizon ahead.

"There's the city."

All I saw was one far spear point stabbing the sky.

"That's the Sheko tower," he said. "One ancient monument that never fell. It stands on a rock in the middle of the river, at the city center now. An island off the coast before the delta grew around it. Anak built a fortress there to guard the river. Sheko knocked it down after he was dead.

"You wonder how I know?" I saw a wistful smile. "I remember from Little

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Mama's tales. Toron says there's a Sheko cult. Pilgrims from light-skinned tribes up and down the coast that still come to worship there."

Periclaw was two really cities, White Water told us as its skyline came into view. Peri was the older, built on the wedge of land where the river channel split on its way to the sea. It had been a stronghold of pirates preying on the river trade until the Norlan slavers seized it. It's a mongrel city now, open to black or white or brown. Claw's across the channel, higher up the river and higher on the social scale. Residence limited to whites and legally registered slaves."

He pointed at a dark bluff that blocked half the channel ahead.

"Blood Hill," he said. "A fort, a prison, and the capitol of the colony."

The channel narrowed as we neared it, and bought us close to the fortress wall. Built of enormous blocks of black stone, it towered from the river edge. Cannon muzzles jutted out of ports high above us. The dark mass of it chilled me with a sense of cruel and ruthless power.

"The guns command the river mouth," White Water said. "The river commands the continent. And Hotlan commands the river."

I felt relieved when we came around the bend, out of the shadow of that lofty wall. White Water pointed at the riverbank just beyond it.

"The fleet yard and constabulary base. The captain says we'll have to leave you there." He shook our hands and gave Kenleth an odd little white metal disk stamped with strange inscriptions. "I found it in a ruin in the jungle. A temple of Anak, the locals told me. It's a Grand Dominion coin. A symbol of good fortune, if you believe the legends."

I was trying to believe in many things. In the mystic power of the crown of worlds shining on Ram's forehead. In some great destiny for him, and perhaps some final rebirth of the lost splendors of the Grand Dominion. In some happy future for Kenleth in a world with no place for him. In our own final safe return to Earth.

But that was hard when I looked back at that black wall and White Water spoke of all the slaves who had died piling up those huge stones. Ram was still the chronic optimist. The crown of worlds still shone. But my own spark of hope had melted into dark unease. When the cook called us down to our last meal on the gunboat, I found no appetite.

Beyond the fortress we came in view of the Sheko Tower. A windowless cone of some brown stone, it had once marked the center of a long bridge across the river. Most of the bridge had fallen to floods and quakes and endless age, but a few great stone piers still stood, and one magnificent arch.

Kenleth asked who lived there.

"Nobody." White Water frowned. "Nobody would want to. Even the pilgrims stay only to kill their goats, bleed their own privates, and burn their gifts to Sheko's ghost."

Beyond the fortress, the river widened into Blood Harbor. A seagoing steamer was loading at the commercial docks, across on the other side of the channel. Ant-small in the distance, slaves in endless files were trotting out of warehouses with heavy bags and bales and boxes, toiling up gangways to the deck.

The captain took the helm to dock us at the military wharves below the fortress. He kept us aboard until a subaltern arrived with a squad of riflemen to take us in charge. They were black, and Ram asked White Water if they might desert and join their rebel kin.

"No chance." White Water shrugged. "They're freedmen. Disciplined well and paid to forget who they are."

The subaltern was a lean young redhead from the north continent, his fair face spattered with gold freckles from

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the tropic sun. The name on his badge was Enec Hawn.

"Ty William White?" He read our names from a slate, stumbling over the "W" phoneme, which is strange to the Norlan dialect. Well briefed to receive us, he stepped close to give me a piercing look, and made Ram take off the black beret to let him study the birthmark. I heard no warmth in his crisp official voice.

"Ty Ram Chenji?"

"Yes, sir," Ram said.

"Where were you born?"

"On another world," Ram said. "We call it Earth."

He blinked and scribbled on the slate.

"What purpose brought you here?"

"No purpose," Ram said. "We've been lost, wandering through this system of connected world, looking for a way back home."

He looked at me. "Where is this Earth?"

My mouth was dry. I had to swallow before I said, "In the sky, far from here."

He squinted again at the birthmark and studied us both. Ram, with his multicolored robe and long jungle knife, might have been another native, but he examined my skin, my glasses, my wristwatch, my worn hiking boots. Keeping a sternly doubtful face, he shrugged and scribbled on the slate.

"Ty Hawn," Ram said, "we have found a new purpose since we came though that stone gate on Mount Anak. I've met the Elders, the elected leaders from the rebel tribes. They've seen this birthmark." He touched the crown. "They take it as a sign that I was born to lead a rebellion to free the slaves. They've sent me to negotiate for a truce."

"So?" Hawn nodded. "They're ready to surrender?"

"Not at all, sir. They are asking Norlan to recognize the Elderhood as an independent republic. They ask for an end to slavery, for guarantees of equal rights for their citizens, for free trade on the river, for untaxed exports to Norlan."

"Ridiculous!" Hawn flushed with anger. "An insane demand! You can't be serious."

"Deadly serious." Ram moved a little closer. "Ty Hawn, I think they're able to take the river back, unless—"

"Nonsense!" Hawn cut him off. "We don't dicker with slaves. We've seen a dozen slave rebellions in the last hundred years. We've put them down and hanged the leaders."

Kenleth shrank from him and caught my hand.

"You'll find it hard to do again," Ram said. "The Elders have resources you don't imagine."

Hawn touched the handgun at his hip. "What resources?"

"Better for you if you never have to know." Ram grinned. "You have a lot to lose."

"Listen, Ty Chenji." His voice fell. "The officer who picked you up had no authority to offer you any sort of amnesty. You offer no certificate of legal registration. Your preposterous demands are high treason."

"I understand the risks," Ram said. "But the stakes are high, for Norlan as well as Hotlan."

"High for you and your outlaw slaves. If you expect any triumph, you should know that the North Sea Fleet has already steamed from Glacier Gulf, bringing two constabulary divisions to recover control of the river."

Hawn's steel-gray eyes moved from him to me and finally came to rest on Kenleth, who clung to my hand, waiting in wide-eyed anxiety.

"If you say you came from a star, Ty White, you may wish you had never left it."

22.

"Ty Hawn—" Ram had begun, but Hawn turned to me. "Come along. I'll see you in my office."

The rifle squad in step behind, he escorted across the dock and through a guarded gate in the fortress wall. Inside,

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we climbed a steep pavement to a second gate in an inner wall that enclosed the whole hilltop. Ugly red brick buildings surrounded a drill field perhaps a mile long. The cannon muzzles we had seen jutted from a third wall around a knob on the crown of the hill.

All three walls were built of the same enormous black stone blocks.

"New to you, Ty White?" Hawn gave me a sharp look when I paused to study them. "They were to me."

"They are," I said. "I've never seen building stones so large."

"If you've never seen them—" He looked at me again as if suspecting that I had. "I had to ask about them. They're relics of what the blacks call the Old Dominion. They were found scattered across the delta, half buried in the silt that had been laid down around them. Quite a riddle to historians."

He halted the rifle squad while he spoke.

"No quarry they might have come from has ever been discovered. How were they worked? They're harder than granite. How were they moved? Every block weighs a dozen tons. Special equipment had to be built and shipped down from Glacier Point to dig them out and lay them in the wall. I've tried to question the natives. They tell me a fairy tale as fantastic as yours."

He gave me another searching look.

"Their black god fell out with his white wife. She invented weapons, raised a great army, and fought a war against him. These stones were in the walls of a fortress he build for his last stand. She won the final battle, killed him, and scattered the stones where we found them.

"Not that I believe it." Hawn shrugged and ordered his men on. "But those stones are still a mystery."

We climbed a flight of steps to a high terrace that looked over the outside walls and across the harbor to the Sheko tower. Hawn dismissed most of his squad, but brought riflemen with us through a narrow door at the base of the central fortress.

Inside, we came into dim a dim twilight. Electricity was unknown here and the giant black block blocks had been laid with no space for ground-floor windows. A few gas lamps, high and far apart, left dismal gloom in a cramped hallway. Guards saluted Hawn, patted me down for weapons, and kept my backpack.

Leaving Ram and Kenleth sitting on a stone bench, Hawn took me down a narrow hall. He ordered Kenleth sharply back when he tried to follow me. I love the vast open spaces of New Mexico. His office was a tiny, windowless box that felt like a tomb. A small black boy squatted in the corner, hauling languidly at a rope that swung a big fan back and forth above a bare stone desk.

He nodded at a chair in front of the desk. "Sit down."

I sat, but he stood behind the desk, watching with a wary hostility, as if I had been some uncaged and dangerous animal. Feeling terribly alone, I longed for Ram's cheerful competence, Derek's grasp of science, Lupe's easy way with people, even Kenleth's childish trust. In spite of the fan, I felt sweat trickling down my ribs.

"Ty White." His sudden voice startled me. "I've seen the intelligence reports on you and your black companion with the headlamp on his forehead. The commission takes no stock in the tale that he's a god come down from the sky to liberate the blacks. They certainly won't discuss the truce he demands.

"As for you—" He searched my face again and his voice grew stern. "You appear to be white. "Your association with him and the insurgents makes you a traitor to your race and your nation. Governor Volmer, however, has authorized me to offer you a chance to save your life."

He sat down, frowning at me.

"Are you willing to answer questions?"

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"I am."

He clapped his hands. A slender pale-brown woman came to perch on a stool at the end of his desk, a pen poised over her notebook.

"You say you come from a place you call Earth. Where is that?"

"It's another planet, sir. Many light-years across the universe."

Hawn and the woman seemed baffled by the English words and I knew no translations. When I tried to explain what a planet was, he cut me curtly off, as if he doubted that other worlds existed.

"What's your age, Mr. White?"

"Fifty-seven Earth years, sir. I don't know how many of yours."

He asked what an Earth year was. I tried to explain that it was the time the planet Earth required to complete its orbit around the sun, but I was lost for words he could understand. He stopped me curtly.

"Enough of your clever jargon. I want the simple truth."

"I'm trying, sir, but I'm too new here to know your language."

The brown women laid her pen down with a helpless shrug. Hawn sat for a time glaring at me, but finally shrugged and nodded for her to continue.

"The inquiry will proceed." His tone was sardonic. "My orders are to hear your story and advise farther action. Describe this planet Earth."

"It's another world, sir. About the size of this one, far off among the stars. Our plants and creatures are pretty much like yours."

He scowled, shook his head, finally spoke again.

"It has people? Whites like you? Blacks like Chenji?"

"It does."

He sat in stony disbelief till the woman murmured something.

"The blacks? Are they slaves?"

"Some were, long ago. We have abolished slavery."

The woman lifted her pen, waiting for his response. His own gaze sharpened.

"You did?" He shook his head. "What did you do with the slaves?"

"The are citizens, sir. Legally, all of us are equal."

"Equals?" His eyebrows lifted in irony. "You call yourselves fellow animals?"

"Blacks are human, sir."

"I must warn you." His voice rose and he began to lecture me. "Any such claim is a crime against the state. Blacks may have human forms, but they are failed creation, stupid, lazy and lawless, animals by law and in fact."

The woman murmured and he slowed his hot voice to give her time to write.

"Whatever fiction you may invent, the world was a special creation, designed to cradle humanity. The sun moves to light our way through it. Plants on land and fish in the sea are there to nourish us. Animals, even your pet blacks, were made to serve us."

His voice rang strong again.

"If the seas are sometimes stormy, if the jungles are sometimes deadly, if the black animals sometimes rise against us, those are trials to test our strength and make us stronger. The blacks are said to hold secret ceremonies for the worship of their black god and a white whore that murdered him. We worship the nature that made us. Heresy is a felony. Preaching heresy is punishable with death."

With nothing to say that might change such opinions, I sat sweating in uneasy silence until he shrugged and spoke abruptly.

"This mongrel child? What's he to you?"

"A friend. He was lost and alone in the jungle. His parents may be dead. I'm caring for him."

"Do you have a license to keep him?"

"If I need a license, how do I get it?"

"I doubt that you can. Licenses are limited and hard to secure." He frowned severely. "If you claim not to know, any

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coupling with animals is strictly forbidden. Guilty females are destroyed, along with the offspring. So are black males, when identified."

The yellow-brown woman held her pen ready. He waited for a moment as if expecting me to speak, but the narrow gas-lit office was suddenly a prison cell, he my vigilant jailor. With no key to freedom, I could only long for the sunlit campus back at home.

"That's your situation." He gave me a piercing glance. "If you want to save your life, I want a full confession."

"Sir," I tried to protest, "I have nothing to confess."

He raised his freckled hand to sweep my words aside.

"I'll be honest with you, Ty White. Frankly, we're asking for your aid." His tone had suddenly warmed. "We ourselves are facing our own ugly situation. Black hostility is nothing new, but remote free tribes are hearing of Chenji and sending men to join the war. Planters and traders have already suffered suffering heavy damage.

"The rebels and their allies are hard to fight. They're using terror tactics. They hit us where we don't expect them and melt into the jungle. Our problem is intelligence. We get lies and rumors enough, but no hard facts. That's what we want from you. A full and honest report on your black companion and the outlaws around him.

"In return for your help, the high commission is offering you total amnesty from the charge of treason." He was fleetingly sardonic. "Nothing is likely to win you any popular welcome as the savior of Periclaw, but we can give you bodyguards if you need them, or arrange a disguised identity. We can even save that mongrel pup, if you like."

Sitting there under the flicker of a gas light at the ceiling of that dusky little room, I felt frozen, numb, trapped, helpless. All I could do was listen to his hard, tyrannical voice.

"Forget your tales of other worlds in the sky and the myth of Chenji's holy destiny. We want to know who you are, where you came from, how you got involved with Chenji."

"We came from Earth, a world that moves around a star too far to see from here. He and I were teachers at a school there."

"That won't save your skin." He barked what I thought must be an expletive and paused to let the woman struggle with my words. "We are not stupid. We are not naïve. We have native agents in the field and competent intelligence men here at headquarters. We aren't children. We're not that easy to deceive."

"You say you want the truth." I spoke from baffled desperation. "The truth is all I have to say."

He shrugged and waited for the woman to nod.

"This is your chance, Ty White." He stressed the honorific. "We want what you know about this these so-called Elders. Their organization. Their leadership. Their weapons, if they have better weapons than their jungle blades. The whole truth."

He waited. The woman looked at me, her pen poised. Thinking of Ram's story of the Elders and his secret initiation, I shook my head.

"If that is all you want to say—"

His face set hard, he clapped his hands. The woman folded her notebook and the come to take me back to the anteroom. Kenleth was there alone, huddled down on the long stone bench.

"Oh, Ty Will!" He ran to put his arms around me. "They took Mr. Chenji away, they wouldn't tell him where. I was afraid I'd never see you again."

He peered at the guard and uneasily back at me.

"What will happen to us now?"

I didn't know.

23.

The prison stood behind the long row

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of red brick buildings we had passed, its tall brick wall capped with blades of broken glass. The warden was a fat mulatto in a brown uniform, his skin a milky chocolate, a license number branded on his forehead. I asked about Ram.

"Special guest." He smiled and spread his hands to greet us, but I wondered what he meant. "No contact with anybody. Orders same for you and unlicensed child."

More amiable than Hawn, if not so literate, he kept us an hour in his office, listening to my story with such close attention that I thought he meant to check it against Ram's. He thanked me as if half inclined to believe it, and put us in a cell on the ground floor, a level reserved for whites.

We were there nineteen days. The cell was clean, the food edible, but those were endless days of uncertainty and dread. The guards were blacks who never spoke. I paced the floor for exercise, but we were never allowed out of the cell. Kenleth wanted to learn English. On the nineteenth morning, to relieve the deadly tedium, I was teaching him to recite lines I knew from Shakespeare's *Tempest*.

The locks clanked. The guards called us out, took us to a conference room, and left us there without a hint of explanation. We sat at a long table there, waiting uneasily, until I heard the guards again. The door opened. An attractive young woman stood there, looking us over with intent blue eyes.

We stood up, staring back. Her skin was fine and very fair, the cheek bones high, her eyes wide-spaced. Straight platinum hair fell free behind her back. Her short white dress looked like silk. On a thin gold chain, she wore a large teardrop shape that glinted with a smoky opalescence.

A faint fragrance came with her into the stale prison air, a fresh sweetness like the lilac blooms in the spring in the bushes along the bushes my grandfather planted along the gravel walk in front of the house. It was a ray of sunlight in the gloomy prison room.

She spoke to the guards. They went out and the door.

"Hello." Well briefed, she knew the English word. "Ty Will White?" Waiting for me to nod, she scanned me again. Her eyes were blue and keen, her oval face quick and pleasant. I thought of Miranda.

She turned to Kenleth. "Ty Kenleth Roynoc?"

He spread his open hands and bowed to greet her, beaming with instant adoration.

"I'm Celya Crail, at the Museum of Ancient History." She gestured for us to sit. "I've read Officer Hawn's report and spoken to Ty Chenji. He tells a remarkable story. I wish to confirm some of the details, if we may speak."

Her interest gave me a spark of hope, though her eyes had a glint of wary caution.

"Certainly," I said. "I know the story may be hard to accept."

"He says you came together from a world he calls Earth? Did you come alone?"

"Two other were with us." I had to assume that Ram had been honest with her.

"What were their names?"

"Dr. Derek Ironcraft and Dr. Lupe Vargas."

"Where are they now?"

"I don't know. We lost them on other worlds before we got here."

"Lost them? How?"

"They were captured and carried away by strange creatures."

"Can you describe those creatures?"

"They were enormous. Their bodies looked to be partly metal. They hopped on great legs and flew or glided on narrow wings."

Watching my face, she asked for more about Derek and Lupe. How old were they? How tall? How long had I known them? Did they have living parents or

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children? If they had been teachers, what had they taught?

She asked to see my glasses and inspected them closely. She asked about my watch. I told her it measured Earth time, and gave it to her. She peered at the jumping second hand, held it to her ear, and listened gravely while I tried to explain why the days of Earth were different.

"A clock." She nodded and gave it back. "I never saw one so small."

She paused to search my face again, and nodded as if with decision.

"Thank you both." She smiled at Kenleth to his delight, and turned back to me. "You seem to confirm Ty Chenji's story."

I caught my breath and asked if I could see him.

"Impossible." The smile disappeared. "I was allowed to interview him, but he is held in strict isolation, under extreme security."

"Ty Ram?" Kenleth's voice was an anxious wail. "Will they hang him?"

"I hope not." She turned very gravely to me. "Your corroboration of his narrative may save his life."

She was with us there in the prison for over an hour, asking more questions. She wanted to know about Earth and our lives there. She asked how Ram had been able to open our way from world to world. What kind of magic had kept the moving roads in motion so long after their builders were dead?

I had no explanation.

My attempt to describe the virtual world and the hidden battlefield bewildered her. She opened a notebook and had me try to draw a diagram of the twin planets and the skywire between them. She wanted a drawing of a cellular robot. She asked what had killed the extinct civilization.

She seemed disappointed when I could only shrug and shake my head.

"The great mystery," she said. "I'm a historian. "My field is prehistory, especially the evidences of the culture that left those monumental ruins buried under the jungle. I had no idea their power extended to other worlds. You and Ty Chenji have revealed exciting hints to the answer. I thank you."

A quick smile dimpled her cheeks. She looked far younger than most historians I had known, and her air of scholarship astonished me. When I asked for more about those hints, she sighed and shook her head.

"We have riddles enough, but no solutions. Explorers have described the ruins and collected native folktales and myths about them. At the museum we are gathering artifacts for a hall of the Grand Dominion. Scholars have tried to decode the writing, but they've found no key."

She sat for a moment frowning at Kenleth and turned back to me.

"On all those worlds, you found no clue to what destroyed them?"

"War, perhaps. We found an enormous cannon or missile launcher beside the moving road. Sections of it had been destroyed, apparently by great explosions. We found weapons and human skeletons in the crater-pitted battlefield hidden under that virtual world."

"That must be the answer." She nodded. "The natives worship a black god who came down from the sky with a white consort to create mankind and rule the Grand Dominion mankind. A golden age endured until he fell in love with his own creation and took human women.

"In a jealous rage, they turned their white offspring into demons and raised an army of them to revolt against him, finally killing him and destroying all his works. The myth may reflect actual events, though the logic of it seems a little twisted. There's evidence enough of violent conflict. Broken walls and fallen towers, ruins buried ages ago.

"I think there was a war between the races."

Trouble on her face, she glanced at

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Kenleth and shook her head. He squirmed uncomfortably and gave me an anxious look. She turned soberly back to me.

"Thanks to Ty Chenji, I'm afraid it's happening again."

"Don't blame him," I begged her. "He was born with that birthmark, but we didn't come here to make any kind of trouble. The gates were a trap that caught us. We've been lost, wandering, looking for any way back home."

"That's what he keeps saying." She shrugged. "It doesn't matter. "He has that shining crown on his forehead. The natives believe he's the predicted son of Anak, sent from heaven to free the slaves and lead them in a conquest of the world."

"The slave rebellion?" I waited for her to nod. "I suppose it is a real threat to Periclaw, but Ram Chenji came out of the jungle at the risk of his life to bring an offer to end it. Isn't there a chance for any sort of truce?"

"He's a fool!" Her voice turned violent. "A fool to leave his jungle hideout. The slaves will never be freed. He could hang by his ribs with the rest of the rebels."

She clapped her hands and rose. The guards opened the door.

"Thank you, Ty White." She spread her hands and bowed. "You and Ty Chenji have answered questions for me. The Grand Dominion was greater than I ever imagined. You've helped me understand what brought it down."

"A race war? Did it have to happen?"

"An ugly war." Her face went bleak. "It killed the civilization that left its ruins in the jungle here. It nearly wiped out all humanity. In spite of the myths, the Dominion was never black. It was a white empire, and based on slavery. Nothing else could account for all the engineering wonders it created. Minds dulled by manual toil could never have reached the other worlds you describe."

The idea startled me.

"That's hard to believe. We saw no hint of human slavery on those other worlds. No evidence of any human labor. Those strange roads moved themselves. The skywire had no human crew. People like us must have lived on the last planet we saw, but they needed no slaves. We found those cellular robots instead, mechanical slaves, waiting to work for whoever knew how to command them."

"That's the point." She stabbed a slim finger at me. "As I told Ty Chenji. The robots left the blacks with nothing to do. With no place in the world. I think they tried to seize the power of the whites, without brains to use it. It was their animal stupidity that destroyed the Grand Dominion."

She shrugged and moved to go.

"Tyba Crail?" Kenleth rose anxiously. "Are we in bad danger?"

"Perhaps." She nodded somberly but gave him a wistful smile. "I'll help you if I can."

His gaze followed her fondly as she left the room, and a trace of her lilac scent lingered in the air.

24.

My breakfast next morning was ham and eggs, with a sort of toast and orange juice, a feast I might have enjoyed back at home. Kenleth's dish held a thick yellow slab of something with an uncertain odor. I shared my tray with him.

"A special order," the fat black warden said when the guards brought us to his office. "Complements of Tyba Crail." He grinned. "You have a friend." I wasn't sure of that, even when he added, "She wants to see you again."

Two rickshaws stood waiting outside his office, each with two blacks yoked to the pole. He released us to a pale brown officer sitting in one. Kenleth squeezed with me into the narrow seat of the other. The blacks ran with us to the prison gate and out through the avenues of Periclaw, which I had never seen.

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"It's exciting!" Eyes shining, Kenleth looked to right and left. "My mother lived here."

It was a white stone city, roofed with clay-red tile, the balconied buildings no more than three or four stories tall. The streets were wide, lined with trees and blooming shrubs. They swarmed with blacks yoked to rickshaws, blacks harnessed to two-wheeled carts and heavy wagons, blacks carrying jars and boxes on their heads.

Yet, save for the muffled hum of human voices, it seemed strangely silent. Muscle power is noiseless, and Periclaw had no mechanized transport. Silent, and strangely peaceful. If the black rebellion was a threat, I saw no shadow of it. From a street that took us to a higher level, I caught a glimpse of the harbor and the twin city on the other side. Freighters lined the docks, but I saw no battle craft, no hint of coming war.

An artist might have made it a scene of peace. The silver-bright canals branching from the riverbank. The white Sheko spire standing on its river islet beyond the ruined bridge and causeway. The flat green delta plantations stretching on as far as I could see. Nearer, slaves at the commercial docks were as busy as ants, loading cargos for Norlan. Our black runners seemed docile, even cheerful, calling soft greetings to friends they met.

Periclaw looked secure, Ram's peace mission tragically forlorn.

The museum stood beyond a long pool of water lilies and well-cut lawns. We left the rickshaws at the white-columned entrance. The officer escorted us up the wide stone steps. Inside, we waited until a yellow-clad mulatto girl brought Tyba Crail to accept our custody.

In a neat white cap and jacket, she was still brightly attractive, still an enigma to me. She had a quick smile for Kenleth, and opened her hands to me in a brisk, official manner. I caught a hint of her lilac scent. She took us into her office, itself almost a museum. Native artifacts hung along the walls: reed baskets, enormous hats, colorful rugs, knives and spears and prayer mats.

She nodded me into a seat before her desk, which faced a great window that looked out across the harbor. It held a sheaf of papers, a stack of slates, and an odd, two-handled drinking up. Standing by my chair, Kenleth saw it and caught his breath.

"My mother!" he whispered. "She had that."

"A lovely thing." She picked it up very carefully and held it for me to see."

It looked like fine white porcelain, the lip rimmed with gold. The handles were green, shaped like palm leaves. One side held the image of a black head that looked almost like Ram's, even to the golden crown of worlds on the forehead. The woman's ivory head, on the other side, could have been modeled from hers, the crown done in black.

"Sheko and Anak." She turned to Kenleth. "You've seen it?"

"My mother traded her diamond ring for it," he said. "It came from a tomb. Ty Hake sold it to a man from Periclaw."

"A unique item," she said. "We bought it for the Grand Dominion collection."

Kenleth's eyes were still fixed on it.

"My mother." He made a sad face. "I think she's dead."

She set it back on the desk and turned gravely to face me.

"I'm removing you from the prison," she said. "For your own safety."

"Who would hurt us?" Kenleth started anxiously. "We aren't hurting anybody."

"People who fear you," she said. "People who fear the power of Ty Chenji. They want to believe his story is a lie. If they got rid of Ty White, there would be nobody to say that it's true."

"Thank you." He wiped his eyes and smiled. "I'm afraid for us, and afraid for Ty Ram."

She turned the cup on her desk and

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sat for a moment with her eyes on the black god's image before she looked back at me.

"You must be uneasy?"

"I certainly am."

"I understand." Her smile held a flash of warmth. "We have talked of prehistory. To help you grasp the crisis, perhaps we should review later times."

She pushed the cup back to its place and sat a moment organizing what she meant to say.

"The Hotlan continent was discovered ten generations ago. The jungles and people here on the east coast seemed so hostile that the first explorers passed it by. The west coast seemed more inviting. Gold was discovered in the sands of the dry riverbeds in the narrow desert strip between the mountains and the sea. Adventures came to wash it out and abandoned their shantytowns when it was gone.

"Settlement of the east coast began generations later. One of my own forefathers was an officer on the first ship to sail into the Blood. He led a group ashore on the delta and stayed behind lived with a native tribe. He learned languages and guided later expeditions up the river.

"His two sons were captains in the Norlan fleet. The elder turned pirate, preying on the river commerce. He built the first fort on the delta. The younger stayed loyal, captured the fort, hanged his brother, and became a one of the first delta planters.

"His son organized the first colonial assembly, to speak for the planters' rights. The assembly is divided now. The high commission, appointed by Norlan, stands against the Blood River Authority, elected by the planters. My father is an authority director.

"Norlan claims the whole continent now, but it has never controlled anything more than Periclaw, the delta, and a few spots along the river. The commission tries to prohibit, tax, and control everything it can reach. The authority fights for free speech, free trade, free traffic on the river. We dream of independence.

"The slave rebellion is the big issue now. Norlan sneers at Chenji and his talk of a truce. They want to believe he's a fraud, that shining mark is some kind of tattoo. They want to hang him and crush the revolt with military force. They expect an army and a fleet from Glacier Bay."

She was speaking freely now, as if quoting arguments she had made to some authority.

"We colonials feel a little differently. The Norlaners might go hungry if their food imports were cut off, but their lives are not in danger. Here on the river we live side by side with the blacks. Planter families have already been slaughtered. And Chenji—"

Absently turning the cup to study the black god's head, she frowned and sighed.

"He's a problem we don't know how to solve. He denies that he's any kind of god, but he can't explain the way that sacred mark glows at night. The natives are convinced that he was sent down from the sky to lead the rebellion and restore the Grand Dominion.

"And you, Ty White—"

She looked up from the cup to frown at me.

"You and Chenji will live or die together. Without you to prove the story of the holy gates and all those other worlds beyond them, he would hang today. Without your tie to him, you could die for treason. You've convinced me that the story is true. Others are harder to persuade, but most of those who want to hang Chenji are willing to listen when I tell them that a dead martyr would do more for the rebels than a live prisoner."

Turning the cup again, she shook her head at Sheko's image as it had spoken.

"So what will happen now?" I couldn't help the uneasy question. "What do you expect?"

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"That's uncertain." She shrugged, her lips drawn tight. "Chenji sees no peace without a truce and some plan to end to slavery. We can't afford that. Our lives depend on slavery. Our whole culture is built on it. Yet the revolt is already killing us. Responsible planters in the assembly are hoping for some sort of compromise that will bring peace with the free tribes and let life go on.

"Feelings are high. Norlaners could lose the continent that feeds them. We colonials could lose our lives. No matter whether Chenji is a divine son of Anak or just a clever liar, both sides blame him for the crisis. Those who fear him fear you just as much.

"That's the way things stand." She pushed the cup aside. "No good for anybody, but I thought you ought to know."

She had smiled again at Kenleth.

"Anak aid you, Tyba Crail." Voice quavering, he opened his hands and bowed to her. "If you can save us."

"I have your custody," she said. "I'm taking you to my home."

25.

Rickshaws waited at the museum door. She got into one and led the way. Kenleth and I followed in another, with two branded mulatto guards running behind us. We came into a section of wider streets and impressive mansions with garden parks or high stone walls around them. We stopped outside a thick-barred wrought iron gate.

"You'll meet my people." She spoke while we waited for a black keeper to open the gate. "My father is chairman of the assembly. He owns a delta plantation, with two thousand slaves. My mother's an Icecape heiress. She didn't want you in the house, but my father insisted and people are curious. She has invited guests for dinner."

Eyes narrowed critically, she surveyed me, my ragged beard and uncut hair, my soiled and tattered clothing.

"You will dress for the affair."

The gate swung open. Inside, a wide pavement curved to a marble-columned portico. A black butler in spotless white met us at the door and fixed Kenleth with a scornful stare.

"You will leave the boy," she said. "He is not permitted in the house. He will sleep in the slave quarters."

"He's not a slave," I told her. "He stays with me."

She frowned severely.

"Residence in Periclaw is limited to whites. Others are not allowed."

"His mother was white."

"He is not." Her voice grew sharper. "Resident non-whites must be registered, licensed, and numbered. They are commonly branded."

I saw Kenleth flinch as if he saw the hot iron coming.

"His mother was born here in Periclaw. Her father was an Authority official. She had to leave the city before he was born, to save her life and his. He didn't choose the color of his skin."

"His misfortune." She shrugged. "The law is the law. Custom is custom. Our ways are own."

"Kenleth stays with me," I said. "Or I stay with him."

"Out of the question." Her face set. "I have your custody. I am responsible for your security."

"I'll take my chances." I put my arm around him. "He's with me. Call him my son."

She shook her head, sternly impatient. "That could cost rights you need."

I drew him closer. She faced me half a minute, anger in her eyes.

"Your choice." At last she shrugged. "His registration can be delayed."

"Thank you, Tyba Crail." He tried to smile at her, but she had turned away.

At a sharp word from her, the black butler shrugged and escorted us up a marble stair to a corner room on the third floor. He shut the door and left us there alone. Kenleth put his arms around me. I felt his heart thumping.

"Thank you, Ty Will," he whispered.

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"I don't like it here."

He stared around him in uneasy wonder. The walls were high; the room seemed enormous. Mosquito nets hung around a huge four-poster at center of the floor. White lace curtained tall glass doors that looked across a railed balcony to a sea of red-tiled roofs that ran down to the broad brown river and a far line of green plantations.

"My mother had pictures," he said. "She lived in places like this. She grieved for her twin brother and the friends she had to leave. I think she was sorry she ever had me, but I do miss her. Terribly."

I myself was longing. For news of Ram. For news of Derek and Lupe, wherever they were. Longing even for my students and my university friends and the tiny crises we used to debate in the faculty senate. Earth had become an impossible dream.

The lock had clicked when the butler left. I tried the door; it didn't yield. I felt a sudden sense of suffocation. We'd been confined too long. Wanting to get out and walk, wanting sun and space and air to breath, I rapped on the door. A huge mulatto guard appeared at last.

"To go outside?" His eyes rolled in astonishment. "Ty, you have no permission."

He closed the door and the lock clicked again.

To endure the empty time, we gave each other language lessons. I recited my scraps of Shakespeare and we tried to translate. Kenleth listened avidly when I tried to answer his questions about Elizabethan England. Earth must have been as strange and wonderful to him as the universe of the trilithons had been to me.

The door opened, late that afternoon, and quiet blacks came in to ready me for dinner. A silent barber shaved me and cut my hair. A black valet measured me as carefully a tailor back at home and came back with the equivalent of a tux. A tight white jacket, tight white hose that came above my knees, a green silk sash embroidered with the Crail monogram.

The butler escorted me down the spiral stair to a spacious hall and steered me to my place at a long dining table, elaborately set with hand-painted china and sterling silver had come from Icecape. Scented candles already burned in the gold chandelier above it.

The guests had not arrived. I stood behind my chair until Celya Crail appeared. In a white silk gown, she looked a fresh and chic as a film starlet back at home. She inspected me critically, adjusted the sash, and showed me around the hall.

The high walls were hung with solemn portraits of the Crail dynasties. In a moment of family pride, she pointed out paintings of a Crail freight steamer, the Crail sugar mill, a steam locomotive on the Crail railway, which ran out of the delta to the coal fields and silver miles a hundred miles north.

Her family came in. Her father was a tall, austere whitebeard, who eyed me sharply through a gold-rimmed monocle he wore on a chain. He gave me a stiff formal bow and turned to mutter sharply at her. She murmured something that made him smile.

Her mother was a lean, hawk-featured woman who wore chalk-white makeup and a crown of bright orange hair. With only an absent nod for me, she turned angrily to scold the butler for a fault I never understood.

Celya introduced the guests when they came in. A uniformed commander from the constabulary. An intelligence officer and his wife. The secretary of the River Authority. Two commissioners from the High Council. A wizened river magnate who owed a stable of racing slaves. Crail's banker, a license quadroon whose fat fingers glittered with diamonds and gold. They gave me casual nods or searching squints or formal bows or stares of cold disbelief, but never an open hand of friendship.

Ram's testimony before the Council was still in progress. Some of the guests

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had questions of their own. Was it true, the intelligence officer asked, that we had come together from that magic planet in the sky? Had I seen any actual evidence that Chenji's great-grandmother had been an escaped delta slave? Had he brought magic weapons with him?

Shrewd eyes on my face, he asked about our missing companions, the magician Ironcraft and his female assistant. Did they really know the secrets of thunder and lightning? Had they really been able to speak to each other around the world? Where were they now? Hiding in the jungle perhaps, casting evil spells for the rebels? He shrugged at last and walked away.

A scornful engineer probed me for more about the magic gates. How had we been able to jump between those worlds in the sky with no wings to lift us or bridges to walk across? The commander had searching questions about the Elders. Were they themselves warriors? Or priests of Anak and Sheko? Did they command the rebels?

A red-haired quadroon artist made me pose for a quick charcoal sketch. She worked for the Crail newspaper. Seeming a little more open than most of the others, she wanted to interview me about Earth and my life there when she could get permission. She never did.

Waiters were offering glasses of some fiery stuff from the Crail distillery. With no response at all when Celya tried to introduce me, the River Authority executive reached for a glass and turned to ask the commander about harbor security.

"No concern." The commander shrugged. "The fleet will soon be here with troops to reclaim the river and put the trouble down."

Standing near, Crail had overheard.

"We do need support from Norlan, but mark my word." He raised the monocle to glare at me turned to shake his head at the commander. "I've heard too much of that blackbird and his puppets. We'll have no peace on the river so long as they are allowed to sing."

"True, sir." The commander raised his glass and shouted for a toast. "Death to that black demon and all the witches with him! Death to all their jungle thugs and every traitor who seeks to aid or arm them!"

People turned to stare. I felt relieved when a troop of black musicians filed in. They were natives, Celya announced, that the museum had brought to display the culture of an isolated tribe in the northwest mountains. Their tunes were a harsh cacophony to me, but they were at peace with Periclaw and they got polite applause.

The butler held a gong for Crail to strike. His voice high and thin with age, he asked us to stand and began the meal with thanks to the Unknown Creator for all his bountiful blessings and a prayer for him to cleanse the errant soul of every traitor with the pain of holy fire.

"Please remain standing," he said, "for a moment of silence in memory of Benkair Var, a daring explorer and a great friend of mine. You may have seen his collections of prehistoric antiquities in the hall of ancient art. He never returned from his last expedition into the unmapped area north of the Blood. I've just learned that he is dead."

"Killed by the *Slubro-slubrok*," Celya added. "Also called the gut worm. A jungle parasite."

A young waitress, uniformed in something stiff and white, stood rigidly silent behind every chair. I was placed at the foot of the table, between the intelligence officer and the engineer. The engineer shuddered and asked if Var's party could have brought infection back.

"No danger," she said. "None of then got back. A rescue expedition has just returned with the tragic news. They found Var's records and cameras in his last camp. Fortunately they escaped infection."

"A nasty bug!" the officer muttered. "Chenji himself makes no threats, but he suggests that the rebels might attempt to use disease as a weapon. The medical

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corps is considering that possibility."

He turned to me as if he expected some response. Afraid anything I said might somehow damage Ram, I kept silent. With nothing to say that he might believe, I felt happy when the actual meal began. The waitress at my place was young and lovely, probably an octoroon, her license number tattooed on her pale cream forehead. She bowed and smiled and said her name was Sherleth.

"I serve you, sir," she breathed at my ear. "Ask for what you wish."

What I wished for was Norlan table manners. My place was set with a vast gold plate surrounded with a bewildering array of silk napkins, bowls and cups and glasses, silver knives and forks and spoons. With no skills for them, I watched the engineer for clues.

He seemed amused when he saw me aping him, and I relaxed a little when it struck me that really I need not worry. Good etiquette could have condemned me as a native Norlaner, a traitor to my race.

The meal came in many courses, elaborate dishes accompanied with a series of alcoholic drinks. Sherleth served me with an eager zeal, refilling every glass or dish I touched, asking what was wrong when I could only taste the liquors and toy with the food.

A hopeless depression had killed my appetite. No matter whether the Council hanged Ram or set him free, I saw that he could never bring an end to slavery. This whole world was built on it. Call these people good or evil or in-between, they would fight to the death to defend it.

26.

The screams of a woman under torture woke me next morning. They continued for nearly two hours, broken with sounds of strangling and gasping cries for mercy. I felt sick and jittery before at last they ceased. Kenleth had slept on the floor, but he woke, crawled into the bed, and lay trembling against me.

It was Sherleth who entered with our breakfast tray when the Guard unlocked the door. She looked drawn and nervous, her eyes puffy and red. Silently, she set our meal on a little table. I couldn't help asking if she had heard the screaming.

"Nobody screamed," she whispered. "Perhaps a happy child was singing."

"She was hurting." Kenleth shook his head. "Bad. Maybe dying. I was frightened. I have no license. Could I be next?"

"You won't be." She tried to smile. "Not now."

"What happened?" I asked. "Can't you say?"

Her swollen eyes fixed on me.

"You are friend of Chenji?" I heard a desperate plea in her voice. "He is true son of Anak? Will set us free?"

"If he can."

"I pray to Anak." Her slender fingers made a fleeting sign. She paused to peer into my eyes. "You will not speak?"

"I promise."

She glanced at the door to be certain it was shut.

"My sister." Her voice fell, and her words came fast. "Ty Crail chose her to bathe him. Favored her too greatly. Tyba hated her for that. Tyba told butler she found her coupling with him in the tub. Not true, but butler fears Tyba. Ty Crail—" She tried to stifle a sob. "He wants no quarrel with Tyba."

She stifled a sob and dropped to her knees.

"Ty," she whispered, "may I serve you now?"

Kenleth tried to put his arms around her. She shook her head and pushed him away. I let her serve our breakfast. Her hands shaking, she spilled a few drops of tea and cried out as if in pain. She wiped her eyes when we had eaten, gathered up the dishes, slipped silently away.

* * *

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Next morning another woman brought our breakfast. We never saw Sherleth again. Kenleth was not allowed out of the room, but the valet appeared every afternoon to dress me for dinner. The intelligence officer, Ayver Krel, was always there to update Crail on the slave rebellion. A wiry little fox-faced man who spoke a dozen native tongues, he had been a corath trader and a collector for the museum.

Day by day, I saw Crail's loss of nerve as Krel reported the revolt spreading down the river toward his holdings. More violence than the river patrol could contain. More planters and traders murdered. More towns and factories burned. More refugees waiting on the riverbanks or crowded into the rescue camps set up for them on the river islands.

Krel always tried to lift his spirits.

"We're secure, Ty. They can't storm Blood Hill with jungle knives. The constabulary can certainly contain any trouble on the delta. The advance flotilla of the fleet is already steaming up the channel."

Crail asked about Chenji.

"His fate is still uncertain. The council would vote to hang him at once, if not for—"

He stopped with a frosty stare at me, down at the foot of the table.

"Frankly, Ty, we face a nasty stalemate. The blacks take Chenji for a son of Anak, sent to throw us off the continent. The white—" He shrugged. "He doubles the dilemma."

I drew a long breath and tried to keep a blank expression. The whole group stared at me until at last Krel proposed at toast to Crail's wife, the "uncrowned queen of Periclaw."

Glasses clinked, and her cold smile wrenched me with thoughts of Sherleth's sister slave and her shrieks of torture.

Krel was back a few nights later news that the whole fleet was now at anchor in the harbor, with ten thousand men aboard the troop transports under command of General Arka Zorn.

"Periclaw's now secure," he told Crail. "And we're stabbing at the heart of the rebellion. Tribes never conquered, up north in the Black River basin, are joining the rebels. Their heads are filled with the poison notion that Chenji's here from heaven to create a new Black Dominion."

The Black River was a major tributary of the Blood, navigable for a thousand miles into territory that only a few explorers had seen. General Zorn would be pushing up it, with a dozen gunboats and four thousand troops.

"With victory on the Black, we can hang the traitors and snuff the trouble out like a dying candle."

With no news of Ram, I dreamed that night that we were back at the trading post upriver. I saw him hanging from that twisted oak, blood dripping from the hook through his ribs. He was gasping for water, but blood filled the cup when I got it to lips.

At dinner the next evening, the guest included the Admiral Kuch, General Zorn, and their staff officers all in full uniform and gleaming with jeweled swords and medals. Zorn was a bronze-haired giant in starch-creased whites and a crimson sash, his voice a raucous bark.

A mulatto Guard and my nearly white waitress alert behind me, I sat alone at the foot of the table, empty chairs on either side of me. Laughing with the officers, Krel gave me a mocking introduction as "the honorable ambassador from the magic planet Earth." When the meal was half over, a sudden silence fell. People turned to stare at the door. Celya Crail and Ram stood there, two guards with them.

"Ty Ram Chenji." She caught his arm and turned to face her parents. "Governor Volmer has released him in my custody."

In the startled silence, the butler escorted them to the empty places beside

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me. Limping, leaning on a cane, Ram wore yellow-striped prison coveralls. His face bruised and swollen, he had a white bandage taped across his forehead where the crown of world had been. He stopped behind his chair and gave me a dismal shrug.

Krel murmured to Zorn and the admiral.

"That black devil!" Zorn was on his feet, stabbing a furious finger at Ram. "What's he doing here?"

Crail gaped at him and then at Celya.

"General, Ty Chenji is my guest." She caught Ram's arm. "The council inquiry is still in progress. We have evidence that he and Ty White are what they claim to be, travelers from another world who meant no harm to us."

"A monstrous fraud!" Zorn blinked at her, then at Ram and me. "They'll hang for it."

"Perhaps." She shrugged. "Charges have been filed. They are not yet convicted of anything, but their lives have been in danger. I have accepted custody to protect them."

"Wasn't Chenji safe in prison?"

"Not safe, Ty. Intelligence exposed a plot to kill him."

"Is that true?" Zorn swung his fury to Krel. "In prison?"

The little intelligence man cringed and braced himself.

"Ty, a guard was bribed to knife him. He disarmed and disabled the guard. His food was poisoned. He lay near death in the prison hospital until Tyba Celya brought her doctors to save his life."

"Who would kill him?"

"The culprit has not been identified." Krel glanced down the table at us. "These men have enemies everywhere."

"General Zorn." Celya spoke beside me. "Ty Chenji is more than my guest. He is a weapon against the rebels. He has traveled in the jungle. He has met the Elders, leaders of the wild tribes that support the enemy. He has given us valuable information about their positions and resources."

"Or misinformation?" Zorn huffed.

"The story of his arrival on Mount Anak has been well substantiated."

"By that white traitor?" He glared at me.

"And others, Ty. His best witness is the double agent known as Toron."

"A double agent?" Zorn scowled at her. "Whose agent? Yours or theirs?"

She looked at Krel, who squirmed and raised his voice.

"Ty, we trust the man. He has been a useful asset for many years. He led the group that saw Ty Chenji and Ty White appear on Mount Anak. He has penetrated the rebel leadership. Their reports have been reliable."

"If you think they are actual magicians from this magic Earth—" Zorn glowered at him. "I think they're enchanted you. I know they've inspired the rebellion. They are a blade in our guts."

A troop of waiters had appeared with platters of broiled quail. The scent wet my mouth in spite of the tension, and Crail rapped a glass.

"Gentlemen, can't we let the meal continue?"

"One moment, Ty. If this splendid son of Anak has appeared to arrange the surrender of Periclaw to a horde of black savages—" Zorn clenched his jaws in indignation, and stopped to squint at Ram. "Can't he speak for himself?"

Celya nodded at Ram. He gave me a wry shrug and turned to face Zorn.

"Ty." His voice rasped and he cleared his throat. "Ty White and I never asked to be here. I'm not the son of any god. I never claimed to be."

"Yet you wore a mark of magic power."

"The birthmark?" He touched the bandage across his forehead. "I was born with it. A small pale freckle. Nothing uncommon, but it had the shape of a crown. Only an accident, I think, but it has been taken for the fulfillment of a prophecy."

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"Nothing uncommon?" Zorn's harsh voice sharpened. "Wasn't it shining in the dark?"

"That's why they cut it out."

He said nothing of his black great-grandmother and her story of escape from another world. Zorn scowled at him and bent to hear something from Krel.

"I am told you command the rebels."

"No true, Ty. Some of them may claim me for a leader, but I have no authority. I have met native people and heard their legends of a great civilization destroyed by war. I came out of the jungle hoping for a peace that would stop it from happening again."

"I think you're a liar or a fool. Likely both."

Wit a nod to Crail, Zorn sat down. Crail clinked his glass. Frozen waiters came to life, refilling glasses and serving the quail. The silent guests relaxed and talked again. Ram grinned at me. I reached to take his hand. He stiffened and drew back. Celya frowned at me, her lips set tight.

"No contact allowed."

27.

Ram was back every evening at dinner, the guards and Celya with him, seated near me at the foot of the table. A white bandage still crossed his forehead, but the bruises healed. The prison stripes were gone, but he looked no happier in his starched and creased formal attire.

Sometimes he winked or gave me a grim little nod, but we were not allowed to speak. Her parents ignored him, but she sat with him, smiled at him, and introduced him to other guests as if he were a welcome friend. The guards were always close.

We saw no more of Zorn. Determined to stab the rebels to the heart, he had gone up Black River with his gunboats, an infantry battalion, a long-range rocket battery, support troops, and a shipload of "crawler cannons." Meeting no resistance, his gunboats were already near Sheko Falls, at the head of navigation.

Krel, the intelligence officer, was always there to share war news with Crail. A second flotilla was steaming up Blood River to pick up refugees and relieve outposts under siege.

Admiral Kuch was often back. A heavy, deliberate man with a hearty appetite and shrewd green eyes in a smooth bland face, he was full of good humor and basking happily in his popularity as the champion defender of the nation. Careful with his ships and his men, he would have been a winning poker player. He held half his fleet held in reserve, still at anchor in the harbor.

He had spoken in the council to oppose Zorn's adventure.

"I've known Arka Zorn since we were cadets," he told Crail. "He always liked a fight, and fought to win. He half killed himself, working to stay at the top of his class. But I'm uneasy for him now. He's never known the jungle. Fighting jungle blacks is like boxing with smoke. They're nomads. They've got no towns. No forts. He can fire his cannon. Maybe hit some savage in his hut. More likely nothing. The jungle doesn't care."

Celya was back with Ram every evening. At first he was stolidly silent, she warily alert. I saw them change. In my freshman classes back at home I had watched a hundred new romances bloom. I knew the signs. The tender glances, the gentle touches, the secret smiles. Like a Romeo reborn and an alien Juliet, they were falling in love.

Her parents were no happier than the Capulets. I saw their hostile stares at Ram, their cold frowns for her. Tears filled her eyes when she looked back at them. Sometimes I caught a grimace of pain. They must have tried to reason with her. She would have said she was an agent of intelligence, assigned to pry for anything that might betray him. What had they to fear from a prisoner under constant guard?

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She must have felt torn between conflicting loyalties, but I saw more smiles for Ram as the romance ripened. I'd first seen her in a plain white dress, her long hair straight and free. It was soon cut shorter, curled, sometimes with flowers in it. Her lacy gowns were styled to reveal sleek white flesh that must have tempted him.

He was silent and restrained, nodding impassively when curious guests wanted to meet him and she had to explain that the terms of his release didn't let him speak in public. They spoke enough to each other, murmuring softly, heads bent together. Their shoulders touched. She often caught his arm. Once I saw his hand on her thigh. I felt apprehension for him, and sharpening unease for Kenleth and me.

Days went by with nothing new about the war. Periclaw and the delta were not yet touched, the commercial docks still busy. Freighters still slid down the channel to the sea, laden with grain, sugar, and rum for Norlan. General Zorn had reached a great waterfall at the head of navigation on Black River. At the last report, he had led his ground forces up the cliffs beyond to attack a reported native stronghold.

Crail was an optimist.

"Like us or not," he told the admiral, "the rebels will come to see the fools they are. They can torch a few buildings and leave good crops to rot, any time they want to hang for it. They forget that they'd be back in the Stone Age without us. They've got to have our metals for every tool and pot they use, our drugs to save them from their jungle fevers, our faith to keep them out of hell."

He raised his voice, staring down the table at Ram and his daughter.

"If you want to see our actual danger, look at those deluded few who want an end to slavery. They call it cruel. Call it wrong. They're blind to the facts. The workers on my plantations live better lives than their jungle kin. They get food and shelter, medical care, safety from their jungle brothers who'd hunt them down for trophy skulls."

Celya flushed and bit her lip. Ram stared coolly back. The shrieks of Sherleth's dying sister echoed in my mind.

Confined to our room, Kenleth was restless as a caged monkey. He tried to talk to the maid who brought our trays and cleaned the room. She would only touch her lips and shake her head. We played catch with green apples. He learned to juggle them. We carried on our language lessons. He asked a thousand questions about the trilithons and the worlds we had seen and Earth itself.

If I ever went back there, could he come with me?

I told him he could, if we could ever escape from the Crails. If Ram came with us. If we could find Derek and Lupe. If they had discovered some way home. If Ram still had his emerald key. If we could find an intact trilithon programmed to take us in the right direction.

A wild dream, but it brightened his troubled face. Sometimes, in the long and anxious nights, I almost believed it. After all, miracles sometimes happened. Nothing was ever quite what you expected. The Sahara gate itself was proof of that.

The war picture suffered a sudden change. One evening Krel and the admiral arrived late for dinner. They burst in together, pushed past the butler, rushed to whisper at Crail's ear. He rose to huddle with them. We sat waiting until he rapped his glass and looked down the table.

"Sad news," his old voice was nearly too faint for me to hear. "Sad news."

He sat again as if his knees were weak and let the admiral talk.

"Until today, nothing had been heard from General Zorn since he left his boats below the Sheko Falls."

He spoke slowly and carefully, perhaps repeating testimony he had given

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the council. Pausing from time to time, he turned to Krel for a word or a nod of support.

"We sent three courier craft upriver to ask for information. The first two never returned. The third has just come back, bringing a man they met on the river in a small boat. He tells a story I didn't want to believe until intelligence could confirm its accuracy."

"Convincing detail came from native sources," Krel said. "The wild tribes keep in touch with drum talk. You hear the drums at night."

"This man had been Zorn's orderly," the admiral continued. "He'd gone on with Zorn above the falls. They'd heard tales of a ruined temple of Anak and a center of native power around it in an area that had never been explored. The orderly says their native guides took them out of the jungle and on across a barren plateau where the vegetation was scant and strange. He describes a plant the blacks call the gut worm."

"Also called Sheko's flower," Krel said. "Or the flower of death. Sheko is their goddess of death."

"A peculiar plant," the admiral said. "It lies flat on the ground. The leaves are black and enormous. A short center stalk carries one huge purple bloom that has a powerful odor. Nauseating, the orderly says, but intoxicating. The natives warned Zorn to stay clear of it, but he felt safe in his armored crawler. He made his driver bring him close.

"The orderly says the stink of the thing made them all so woozy that he's not sure of all that happened, but the flower spat something that hit Zorn and stuck to his face. Maybe some sort of seed or fruit. It looked like a ripe plum, but he says it intoxicated Zorn. He sniffed it, tasted it, swallowed it whole.

"He seemed to sober up, the man says. He was able to go on to the ruins, which the orderly describes as a mountain of broken stone. Great black blocks, he says, like those constabulary center is made of. He believes the place had been a fortress rather than any kind of temple.

"Zorn got sick there. Out of his head and finally so weak they carried him in a litter. On the last night he was screaming in agony. The orderly called an army surgeon, but Zorn ordered them both out of the tent. Next morning he was gone.

"The orderly left the details out of his written report, but under oath he swears that he found an enormous black-scaled snake coiled on Zorn's cot. He claims he wasn't drugged or drunk, but he swears that the snake cursed him in Zorn's voice before it crawled out of the tent and disappeared into the ruins. Nothing was left of Zorn except his empty skin."

The admiral hesitated and turned to Krel.

"The surgeon failed to save the skin," Krel said, "but the orderly did get back with his journal. The illness is diagnosed the illness as an internal parasite. He never saw any snake. A paragraph of speculation is broken off, unfinished. The final entries in the journal are devoted to another jungle illness that nearly killed the orderly himself."

The admiral shook his head at Crail. His voice stuck when he tried to speak. He picked up a glass and gulped something that wasn't water. Strangled on it, he coughed and wheezed and gasped for breath.

"A frightful thing." His voice was a husky squeak. "I hope it never gets here. The native name for it translates as blood rot. It hit them at the ruin. The first symptoms were a high fever and a burning rash. The victims went fast, the surgeon writes. They bled profusely in the final hours, from all body orifices. The entire bodies—"

The admiral lost his voice again and clutched the table to keep his balance through another fit of coughing.

"The entire bodies dissolved into blood. The orderly swears that it was fatal to every white that caught it. He says the blacks were immune. The hybrids were commonly sick. Quadroons and

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octoroons had high fevers and sweated blood, but they nearly all recovered. The surgeon hoped to use black blood to develop a vaccine, but he was dead before he had a chance to try."

"Dead?" Trembling, Crail caught the admiral's arm. "Dead of what?"

The admiral had to cough again.

"That jungle fever. They retreated and took the infection with them. The orderly is an octoroon, and he was sick with it when he got back to the falls. He says it swept the crews and troops waiting there. He says he was out of his head, but he remembers panic, with mutiny and fighting, before he was carried on a hospital ship.

"Recovering, he found himself the only man left aboard. The ship was aground in the channel. He says all the ships were empty, most of them beached or burned. Any other survivors must have disappeared into the jungle. When he was strong enough, he found a boat and came on down the river."

Crail gulped something that took his voice and left him doubled over the table.

"Survivors?" he gasped at the admiral. "Where are the survivors?"

The admiral turned to Krel and waited for his shrug.

"Ty, there were no white survivors."■

To be concluded

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The Boy Who Would Live Forever, Frederik Pohl, TOR, $25.95, 381 pp. (ISBN: 0-765-31049-X).

The Exiled Prince, or The Archquisitor's Tale, a Romance of Nova Europa, Robert Reginald, Ariadne Press, $24.95, 600 pp. (ISBN: 1-57241-125-2).

Sliding Scales, Alan Dean Foster, Ballantine Del Rey, $24.95, 245 pp. (ISBN: 0-345-46156-8).

Dragon and Soldier, Timothy Zahn, Tor, $17.95, 301 pp. (ISBN: 0-765-30125-3).

No World Warranty, F. Alexander Brejcha, iUniverse, $17.95, 263 pp. (ISBN: 0-595-31841-X).

People First! F. Alexander Brejcha, iUniverse, $16.95, 275 pp. (ISBN: 0-595-31860-6).

Laugh or Cry: Finding the Lighter Side of disABILITIES, F. Alexander Brejcha and Sharon M. Hulihan, iUniverse, $15.95, 142 pp. (ISBN: 0-595-32257-3).

The Cat's Pajamas and other Stories, James Morrow, Tachyon, $24.95, 209 + xvi pp. (ISBN: 1-892391-15-5).

The Best of Xero, Pat and Dick Lupoff, Tachyon, $29.95, 272 pp. (ISBN: 1-892391-11-2).

It might well be the conclusion of the Heechee Saga, but with Frederik Pohl, you never know. The saga began in 1977, **The Boy Who Would Live Forever** is volume six, and Pohl is still thinking and writing. The question is what he's come up with now, in the first true Heechee novel since *Annals of the Heechee* (reviewed here in December 1987) (1991's *The Gateway Trip* was a patchwork collection of bits and pieces).

The protagonist is Stan Avery, just a kid, a teen in Istanbul when his Dad dies in one of the System-wide fits attributable to the wet dreams of Wan Enrique Santos-Smith, long marooned on a Heechee station in the Oort Cloud. Fortunately, there is enough insurance to get him and a friend to Gateway. Unfortunately, there is not much need left for sacrificial-lamb prospectors. Fortunately, he lucks out with a young lady, Estrella, on a ride all the way to the Core where the Heechee have been hiding all this time from the Foe who once destroyed all sentient life they could find. Of course, time in the Core runs slower than in the outer galaxy (by a factor of 40,000 to 1—a day is over a century!). So while Stan and Estrella discover each other's charms and learn a bit about Heechee society—including how delighted they are to have humans joining them in the Core—time Outside whizzes on. Wan demonstrates his capability for deviltry and his hatred of the Heechee. Humans and Heechee discover they can actually collaborate with the ancient Foe. Wan is "vastened" (uploaded to virtual life) and retains his capacity for deviltry, his hatred, and his interest in weaponry that might be able to explode a sun. More people immigrate to the Core, and even though many are "stored minds" (uploads), it's getting

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crowded. And then Wan starts collecting other stored minds that share his hatred and have skills such as the ability to pilot starships.

When an Outside star explodes, there is speculation about how if such a thing happened inside the Core it would generate a blast front that would destroy millions of Heechee and humans! Was the Outside explosion natural or induced? No one has a good answer, but that's when Stan and Estrella, off on a trip with a rather twitchy Heechee named Achiever in his new type of very fast ship, are hijacked by Wan's minions.

An evil plot is clearly afoot. Will Wan succeed in his insane ambition? Who can stop him? Surely not Stan, for he's still just a kid even if he and Estrella are about to become parents. Furthermore, they're caught in an escape-proof trap on an Outside planet. And when they learn the Core has only twenty-four hours to live . . . Fortunately there are other, more potent actors on the stage. There is also that 40,000:1 ratio.

Where does the title come in? Consider that a human lifetime is on the order of a century. Given that 40,000:1 ratio, Stan might live for something like four million years; surely close enough to "forever" for government work. Add in the uploading as his eventual option, and he has a rather expansive future ahead of him.

The Gentle Reader's time horizon is a bit shorter, but *The Boy Who Would Live Forever* is quite good enough to make a bit of it pass in satisfactory manner. And yes, Pohl leaves things open enough at the end to permit a sequel or two.

Michael Burgess has spent many years as a librarian at the California State University, San Bernardino. He has also been an editor and publisher (Borgo Press) and a scholar of SF ever since his first book, *Stella Nova* (1970). Now, under his Robert Reginald pen name, he brings us **The Exiled Prince, or The Archquisitor's Tale, a Romance of Nova Europa**, the second in a multivolume history of an alternate Europe. Yet it isn't just alternate history. Nor, despite the trappings of myth and magic, is it mere fantasy. Lurking in the backdrop are mysterious figures who can create multiple versions of reality—of Europe—in order to generate a hero capable of serving the needs of a greater world. Perhaps they are mages, but there is a strong "what if" component to their labors that brings Reginald's alternate history fantasy close to science fiction.

Unfortunately, whatever is going on at that level cannot become clear until a few more books down the road, if ever. We must enjoy *The Exiled Prince* in its own terms, which are quite sufficient. It is 1450 in Sabbedelle, capital of the land of Neustria, when the ecclesiastical cops, the Hounds of God, burst upon the royal family at dinner and slaughter the king and all his male heirs save one, Theodoric, who has the presence of mind to dive for cover. Soon the bishop, or archquisitor, Malateste, has declared himself regent for the infant queen and Theodoric a fugitive wanted for the murder of his kin. But Theo, despite being a bit of a wastrel, has friends. He escapes, stays free while Reginald makes Malateste's evil nature and grandiose ambitions clear, and gains a powerful ally in Ludhi, daughter of a family of charcoalers dwelling in the mysterious Tristesse forest. The queen mothers are imprisoned, but they are resourceful and are soon scheming to regain their own. When Malateste moves north to conquer neighboring Parisia, they make their move. So does Theo. And of course . . .

Ariadne Press is a small outfit whose website (www.ihighpoint.net/stores/ariadne) says it is dedicated to translations of works on Austrian history, culture, and thought. It seems to get into the science fiction and fantasy business via such books as Rottensteiner's *The Best*

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of Austrian Science Fiction and the novels of Gustav Meyrinck (among others—go look!). How it got into modern American, quite non-Austrian fantasy is a bit of a puzzle, but be glad they did it. *The Exiled Prince* could easily have come from a major SF&F house, it is a well-told tale set against a richly detailed tapestry of life, the characters live and breathe better than those in the vast bulk of commercial fiction, and it should deeply satisfy all readers who love epic fantasy.

Alan Dean Foster brings us the tenth in his long-running, popular saga of Flinx, the genetically engineered super-youth, and his poison-spitting Alaspinian minidragon, Pip, with **Sliding Scales**. The series began with *The Tar-Aiym Krang*. Flinx's origins were recounted in *For Love of Mother-Not* (reviewed here in Mid-September 1983): As an orphan, Flinx was auctioned as a sort of slave. Mother Mastiff, aged curio dealer in the low-life district of Drallar, main city of the planet Moth, bought him for unclear reasons. Love grew between them, and Flinx grew boldly streetwise. His empathic talent appeared, and one night a sense of lonely hunger drew him from his bed to an alley garbage heap, where he found the minidrag, Pip. Soon the remaining mad scientists of the Meliorare Society are hunting down their prize specimen, and the poor boy is on the run, demonstrating a distinct talent for adventure that in due time earned him the gift of a remarkable starship from illegal aliens. He also found that his unique talent made him sensitive to an inimical force rushing toward the galaxy from far, far away.

In the last book, *Flinx's Folly* (reviewed here in January-February 2004), Flinx learned that he was the key to stopping the onrushing doom, but a secret cult didn't want the doom stopped. With minions on his tail, he fled to Clarity Held, one-time romantic interest. When that book ended, she was a bit damaged and Flinx had a new mission to find an ancient super-weapon that just might be able to ward off the doom.

Now he's depressed. He misses Clarity, he feels swamped by the futility of his mission, and he wants to chuck it all. But the AI of his ship is a wise sort of thing. It suggests a vacation and even comes up with a planet far away from it all. Unfortunately, though the natives are charmingly quaint things a bit like hopping mushrooms, the planet is infested by the reptilian AAnn. The AAnn haven't annexed it to their empire yet, but that's the scheme, and of course the human-thranx Commonwealth is their bitterest foe.

So Flinx is greeted with suspicion, and before long his guide, the scheming bureaucrat Takuuna, has knocked him over a scenic cliff. Since the book still has two hundred pages to go, the Astute Reader is not terribly surprised when it turns out that Flinx survives (although he does lose his memory). Meanwhile Takuuna is desperately trying to manufacture evidence that Flinx is a spy and agent provocateur responsible for a rash of deadly bombings, even as he investigates local dissidents.

Sliding Scales does nothing whatsoever to advance the saga, unless future episodes are planned to require unlikely allies. I wouldn't put that past Foster, but for now, this one is entertaining enough, it's Flinx being Flinx, but it's also a bit of a placeholder, designed to keep fans happy until something more substantive is ready. If you're following the saga, you won't miss a thing by skipping this one. If you're a die-hard Flinx fan, it's a must-have. Budget your book money accordingly.

For young adults who tend to confuse science fiction and fantasy: Timothy Zahn's **Dragon and Soldier** follows *Dragon and Thief* with the continuing adventures of Jack Morgan and his sentient dragon tattoo.

Well, it's not really a tattoo. It's an

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alien named Draycos, a poet-warrior whose folk, the K'da, can shift from three-dimensional form to two-dimensional form on the hides of their humanoid Shontine symbiotes (and never mind what happens to the mass). Draycos was part of a scout force leading the way for a refugee fleet fleeing an implacable enemy. Unfortunately, the scouts were attacked, and when Jack arrived on the scene, he was the only survivor.

Jack is just what you'd expect for a kid raised by a con man and thief, but Uncle Virgil died before the saga began. He "lives" on only in the computer of Jack's ship, and he doesn't really approve when Jack and Draycos become partners, or when they decide on revenge. Since mercenaries were part of the group that destroyed the K'da-Shontine scouts, they decide Jack should join up with the nearest mercenary force, the Whinyard's Edge. He manages to slip into a group of kids whose parents had sold their indentures, and soon he is in accelerated basic training. But among the other kids is a girl, Alison Kayna, who seems to know a bit too much about what is going on, and after Jack tries to sneak into the Edge computer system to learn what he needs, he, Alison, and a few others are pulled aside for what turns out to be a rather strange mission.

Which Jack of course survives, inching a little closer to acquiring a proper K'da warrior ethic but no closer to solving the mystery of who attacked the K'da-Shontine scout force, or why. But there is a goal for the next volume, as well as a hint of future complications with Alison.

Very smooth, fast reading, definite space opera, but the 2D/3D dragon, though it's a nifty, is a bit much to swallow. Speaking of which, since the human body is, topologically speaking, a donut (a cylinder with a hole through its middle), and exterior skin shades smoothly into interior mucous membrane, what is to stop Draycos from layering himself on Jack's interior hide? That would be a great way to hide out!

When *Analog* writers go to cons, they often wear buttons proclaiming that they belong to the "Analog Mafia." Unlike the Cosa Nostra, this Mafia has an air force, for F. Alexander Brejcha, despite being confined to a wheelchair by multiple sclerosis, flies sailplanes. His armament, with which he confronts all obstacles, consists of determination and humor, both of which are on display in the stories—often featuring protagonists who are paraplegic, blind, or otherwise hampered by disease or injury—that he has provided this magazine over the last decade and a half.

His first novel, **No World Warranty**, is now available. It is based on two of Brejcha's earlier *Analog* tales, "StarStep" (April 1990) and "The New Land" (June 1990). In 2200, Earth is stricken by a nanotech plague, leaving the Moon on its own. Serena, half Grounder and half Lunie, is physically different. Picked on by peers, she vows to overcome her difference. In due time, she becomes a brilliant computer scientist. In 2257, Jim Martin is waiting for his parents to show up for his high school graduation when word arrives that they are dead. Since his mother was a Representative to the world government, Jim vows to change his plans and become a politician. In due time, his aircar suffers sabotage just like his parents', but instead of dying he only loses his legs. Since nanorepair doesn't work on him, he gets prostheses. And then, when he loses his battle to revive the sleepers frozen after the nanotech plague, he is offered a new project: finish StarStep, a smallish world orbiting Epsilon Eridani, terraformed into livability, populated with Earthly creatures gengineered to breed quickly, and now awaiting human colonists. Unknown to Earth, however, a group of cougars have developed intelligence and begun developing a primitive culture.

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Jim promptly teams up with Serena and her remarkable AI, Star. Before long, he solves the remaining problems, and the colony can get started. There are problems, not least because the cougars pose special problems, but everything marches pretty smoothly along until the upbeat end. Brejcha's characterization and technical ingenuity are easily up to par, but his plotting is linear, lacking the complexities that we expect in novels from major publishers such as Tor. The final impression—despite a bit of sex—is that the tale is most likely to satisfy young adults.

You will find many of Brejcha's *Analog* stories, along with a number of others, including some that editors thought "too handicapped" or "too SF," in **People First!** Like Brejcha himself, who was an art student until his MS diagnosis, shifted to psychology, found work as a night-shift hospital telephone operator, and took up writing on a laptop during quiet times, his protagonists are coppers. Yet the conditions of their lives are not quite the same as ours; they must live with constraints of mobility, catheters, and uncooperative bowels. For most of us, that would be quite enough. But Brejcha's characters go on to cope with murders, aliens, romance, and other problems suitable for fiction. Brejcha pushes the value of positive mental attitude, and perhaps it is no surprise that he writes for disability markets too and maintains an award-winning disABILITY resource web site at www.netreach.net/~abrejcha.

You will find a similar attempt to promote acceptance and coping in his and Sharon M. Hulihan's **Laugh or Cry: Finding the Lighter Side of disABILITIES**, a collection of anecdotes centering on the inevitable embarrassing and/or hazardous moments in the lives of those who must rely on wheelchairs, adapted vans, walkers, helper animals, and so on. Brejcha and Hulihan (an award-winning Hollywood producer) share their MS; among the other contributors of anecdotes, you will find blind Joe Lazzaro, another *Analog* writer.

The two books together hold great potential to help the disabled adjust, and I plan to make them available to any of my students who may need them.

Personal note: My brother Walter suffered from MS for many years before his death from lung cancer (metastasized liver cancer) in 2003. He never needed a wheelchair, and he never accepted the value of assistive technologies such as computers, which might have let him maintain longer his career as an artist. These books might have been good for him, though he was infamous as a curmudgeon and might well have refused to open them.

James Morrow is famous for his deft, witty, and irreverently brilliant satires, as displayed in *Towing Jehovah, Only Begotten Daughter*, and many more novels. He is guilty of the same sins at shorter lengths as well, and for proof I offer **The Cat's Pajamas and Other Stories**. Here you will find "Auspicious Eggs," a vision of a Catholic Church that tests each newborn for procreative potential. For those with none, baptism is combined with last rites. There is also erotic performance art in "The Wisdom of the Skin," the life-affirming nature of horror films in "Come Back, Dr. Sarcophagus" (original in this book), zombie chore-ography in "The Zombies of Montrose," and a very interesting line on keeping the minds of judges on their jobs in "Fucking Justice" (also original here).

Satire is not for the easily offended. Neither is Morrow. The rest of you—have fun!

Did you know that Roger Ebert is a classic fanboy? I didn't either, until I saw him fessing all in his introduction—"How Propeller-Heads, BNFs, Sercon Geeks, Newbies, Recovering Gafiators, and Kids in Basements Invented the World Wide Web, Except for the Deliv-

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ery System"—to Pat and Dick Lupoff's **The Best of Xero**. And yes, he does defend the claim in his title, even fairly reasonably. Fandom indeed did fill those needs of geeky kids that are today met by the Web and its chatrooms.

So what was *Xero*? A fanzine, started in the summer of 1960 by Pat and Dick Lupoff because they were intrigued by other fanzines they had seen. The aim was to publish material that was both interesting and substantive, and over the 'zine's ten issues, they succeeded well enough to cop a Hugo Award. Today the interest is historical, for FrontPage has replaced the classic mimeograph (the Lupoffs still have one of those in their basement, over which they wax nostalgic) and many of *Xero*'s young contributors have moved on. Consider the names in the table of contents for this *Best of* volume: Harlan Ellison (reviewing *Psycho*), James Blish (about *Captain Video*), Algis Budrys (a loc or three), Ebert (poetry), Donald Westlake (infamous diatribe against the SF publishing industry), Ed Gorman, Avram Davidson, Don Wollheim, Bob Tucker, Lin Carter, Jack Chalker, Frederik Pohl, L. Sprague de Camp, Walter Breen, and many more. Some were still kids, some were starting out, some were already established. Today, none of them are kids, many are no longer with us, and quite a few have become stars in SF and other fields.

This is one for both those who remember and those who don't, but still take their fanac seriously.■

IN TIMES TO COME

One of the classic themes of science fiction is, "If this goes on . . ." No doubt you can easily apply that to many things you see around you at the moment, but next month Kyle Kirkland's novelette "Company Secrets" focuses on an intriguing and disturbing extrapolation of one trend that, if you're unlucky, may have given you more reading time than you wanted. Just how far can downsizing go—and with what consequences?

Stephen L. Gillett appears in two capacities. "Artificial Photosynthesis" is our science fact article, about a kind of solar energy technology that deserves more attention than it commonly gets. "*Analog* Computing" is another part of our ongoing celebration of this magazine's 75th anniversary: a quantitative look at how the special character of this magazine, and its readers and writers, has evolved over those decades.

Our April 2005 issue also features a variety of stories by authors including Brian Plante and John G. Hemry, and, of course, the grand finale of Jack Williamson's novel *The Stonehenge Gate*.

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BRASS TACKS

Dear Stanley Schmidt,

I am a long time reader of *Analog*—from before it went to the large magazine and back again—and still have most of the copies, which I hope will be given to the local library through the Sci-Fi library here in Toronto.

I have found most of the fact articles a bit beyond me as my university and post-graduate education was not in a scientific field. Thus I did not read them very often if at all.

"We Are Legend" is not one of those articles. It should be read by every responsible person throughout the world and particularly those that say that instruction on the use of condoms should prevent funding of the necessary other means of fighting the disease.

We have already had reinfection of more powerful strains so that we now have to treat not one, but two diseases. At least our government in Canada does not hold back on such information and has immediately told the public through its health services and by the Canadian Broadcasting Company.

The world and its leaders have a job to do and Laura M. Kelly's article as a bugle call to war on those who would stop any effective means of preventing the spread of the disease.

Thanks again for having the guts to publish this article and taking it out of the rarified air of academia.

George W. Brigden Q.C.

Dear Stanley,

It is true that there is relatively little work for "repairmen" on modern electronic devices. I was a professional technician for years before I became a software engineer and spent the rest of my career supporting electronic manufacturing. I found that many of our electronic devices are not repairable because of a combination of incredible complexity and really efficient manufacturing techniques. The equipment we buy these days is incredibly cheap for what we get, but is not particularly repairable because of such things as multilayer circuit boards and 1x2 MM sized surface mounted components. It costs very little to create a very complex circuit with a lot of very inexpensive components. Putting in "a separate, easily removable and replaceable part" such as "the jack" makes the device much more expensive since the separate jack requires much more manual labor. The reason why you can buy a TV for $150 is that the manufacturing cost is way less than $75 including all of the incredibly complex PC boards, the case, the CRT and etc. Not particularly because of cheap foreign labor, but because of highly expensive Japanese surface mount machines.

The reason why there is no control on the back is because the vertical linearity circuit is based on a phase-locked loop, which needs and can have no adjustment. Fortunately, such circuits seldom ever fail because if they do, even the best technician is not likely to be able to find or replace the failed component, but if he could, his time, at a reasonable rate, would exceed the retail cost of the device. Sad but true. Our desire for ever smaller, more complex, cheaper devices has made many complex devices disposable rather than repairable.

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On the other hand, there is actually a lot of work for repairmen of a different sort. I got laid off and my type of work was out-sourced overseas. Being 62 and over-qualified, I retired. Rather than pulling the covers over my head and staying in bed, I began my own business making house calls and fixing computers. It turns out that there's a lot of work for people who repair computers and networks, at very good wages. Fortunately, the trend for out-sourcing computer support offshore makes a lot of normal people look for someone who will come to their house and fix their problems.

There is work for repairmen, but not fixing TVs and cell phones. They are gainfully employed as I am or perhaps fixing new cars with 50 computers inside.

I have been a subscriber to *Analog* since it was *Astounding*, and it astounds me that I am lecturing the editor on something he really knows. We have seen more change in technology in our lifetimes than between the birth of mankind and our birth. This is true for even for someone much younger than you or me. Technology is changing at an exponential rate. The paradigms have to change with it.

Dave Broyles

Dear Stan,

By chance your October issue with your editorial on repairman landed on a half read article in *Science News* (July 24/04) about the Hubble telescope. The astronomers involved with the Hubble are deeply skeptical that even state-of the art robots can deliver batteries and gyroscopes, let alone carry out plans to install a new infrared camera and ultraviolet spectrograph. I also suspect it will be a lot more expensive than anticipated to develop and test a robotic system that has a very high chance of succeeding. The chances of success could be raised greatly and the cost in the robotic development program could be reduced significantly if an astronaut repairman was sent up in a Soyuz capsule to assist the robotic operation.

Dave Moore

Dear Dr. Schmidt,

I just finished reading the November 2004 issue of *Analog*. In Brass Tacks, a reader complains that he did not like the serial, *Camouflage*. I agree with your response to that person, but I'd like to add my own.

I liked *Camouflage* quite a bit. In my opinion, the story was interesting and I found the pacing at which the story developed appropriate. Some scenes could have been cut to shorten the story but I enjoyed reading those scenes and I think they helped to establish the background and motivation of the characters. Overall, I think it was one of the better stories *Analog* has published recently.

I also did not mind the sex or violence. The real world contains both sex and (unfortunately) violence. My own personal opinion is that authors who shy away from appropriately including those subjects tend to produce unrealistic stories that resemble those in my young son's board-books.

While I liked *Camouflage*, *Analog* has also published many stories (including some long serials) that I found to be boring or that I thought were outright stupid. If those should ever prove to be the majority then I can simply cancel my *Analog* subscription and subscribe to some other magazine. But I don't think I'll ever suggest that *Analog* reduce or stop its publication just because I don't like *Analog*'s contents . . . Doing so would imply that I thought that magazines should only be able to publish materials that I like. And imposing one's opinions on others in that way seems like a rather asinine thing to do.

Dr. Jim O'Brien

Dear Stan,

Excellent response to the Larry Diersen letter (Brass Tacks, November

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2004). May I add my two cents?

I understand Mr. Larry Diersen's distress over the vivid scenes in Joe Haldeman's *Camouflage*, but I personally found the novel powerful and significant in a way that would have been less meaningful had these scenes not been included.

Haldeman's themes often include the helplessness of frail humans in the face of natural or institutional forces. The rape scene, which incidentally was not graphic to the point of naming body parts, was a riveting way of showing that the alien, a natural creature and part of the universe, was both amoral and unable at that point to empathize with humans.

The other distressing scene which Mr. Diersen might have taken issue with was the Bataan death march. This was part of history, and it's part of our reality. If we deny the horrors of war—or the amorality of nature—we risk the opportunity to change human behavior so that such horrors will not be repeated.

Nature is not always our friend, and history isn't always pretty. At some point, people have to come to grips with these facts, or else they will be unable to cope with the real world.

Possibly Mr. Diersen gave a subscription to a teen relative (the vocabulary and science content are too sophisticated for a person much younger). While I understand his desire to protect the young from the bad things that happen in reality, the serial did have a clear warning as to its disturbing aspects. *Analog*, in my library system, is not shelved in the young children's section.

Thanks for a great magazine,
Mary A. Turzillo
Berea, OH

Dear Dr. Schmidt:

I enjoyed your editorial "Attack of the Giant Oxymorons" in the November 2004 issue. I have two comments.

First in (slight) disagreement: While "war for peace" is an oxymoron, "fighting there rather than here" or "fighting a small war now rather than a larger war later" are not.

The second requires some background. Last month, I was on jury duty. At lunch and on breaks the nine other members of the panel (civil case, eight jurors and two alternates) could talk about anything but the trial. I would like to emphasize that these were fairly intelligent conscientious people. There where two lawyers, an airline pilot, a retired scientist, a commercial photographer, four business people, and myself (systems analyst). Near the end of the trial, the subject of the draft came up and I found myself the lone proponent of volunteer military service. All of the others contended that the draft was preferable because it was "fairer."

When I gave my (to me at least) most compelling argument—that a volunteer force was better (more effective) than a conscripted force—they shrugged it off. "Just the price to be paid for fairness."

Bill Wenrich

People find lots of ways to argue one side or the other on conscription, but hardly anybody seems willing to face head-on the fact that it's an example of something expressly banned by the Constitution!

Dear Stan,

I can't help adding my favorite Giant Oxymoron: "Mandatory Gratuity." Recently a restaurant patron in New York was arrested for failing to be sufficiently gratuitous. I guess sooner or later we will be jailed if we fail to exercise our voting rights. Language perversion matters.

Dan Culbertson
Merritt Island, FL

Dear Stan,

Well said. I chuckled. My first introduction to the word "oxymoron" was with the reading of a newly introduced book: *1984*. I was attempting to under-

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stand (?) the government slogans!

Now at 50, I am rereading many of the dystopian novels: *The Handmaid's Tale*, *Fahrenheit 451*, *Brave New World*, and perhaps for a vision of a ruined ecology, *The Sheep Look Up* should be included.

I would love to see an editorial or discussion of the value of these dystopian stories. True, things didn't turn out as badly as they foretold, but my understanding, aided by maturity and experience, stirred powerful emotions to these messages that are perhaps more ominous in this century.

A fan,
Linda Cash

Dear Dr. Schmidt,

When I was in college, I wrote a story for the college magazine and had the experience of having an English professor tell me all the wonderful meanings I had included in the story. I remember wishing that I had, in fact, meant to include those meanings.

I recount this tale to introduce the concept of subtexts: things you didn't actually say, but which are conveyed to the reader nevertheless. To be a proper subtext, the information should either be conveyed to the majority of readers or should be reliably conveyed to people familiar with the context or subject matter. The question of the author's intent is open. (I'm not sure whether the multitude of meanings attributed to James Joyce's writings should be included or not, on the basis of "reliably.")

Periodically, you take a letter writer to task for arguing against something you didn't say. I think you are always (almost?) right that you didn't say whatever it was. I think you are also usually right that the issue was a proper subtext. On the other hand, suppose you personally feel strongly about issue A, but very carefully raise the issue neutrally. Your text does not commit you. A careful reading demonstrates this. However, if you have used some phrases that are commonly used by one side of the issue, but not the other, or if your style of argument parallels that of one side, may not that proper subtext be there?

On the third hand, as an editorial writer, have you ever purposefully couched an argument in such a way that you are technically innocent of the imputed argument, but have included a subtext to invite disputatious responses?

Oxymoronically yours,
Dean Hartley
Oak Ridge, TN

P.S. I'm not sure what I mean by the closing, but it sounds good.

Subtexts do exist; the rampant problem in our culture is that English teachers bent on ferreting out hidden meanings whether they're there or not have made people way to sure that they know what other people's subtexts are! ■

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UPCOMING EVENTS Anthony Lewis

4–6 March 2005
COASTCON XXVIII (Gulf Coast SF conference) at President Casino Broadwater Resort, Biloxi MS. Author Guest of Honor: Mark Worrell. Media Guest of Honor: Walter Koenig. Fan Guests of Honor: Walter & Judy Johnson. Artist Guest of Honor: Carl Lundgren. Registration: $30 until 31 January 2005, $35 at door. Info: www.coastcon.org/index.shtml; coastcon_inc@yahoo.com; CoastCon Inc., Box 1423, Biloxi MS 39533.

11–13 March 2005
CONSECRATION 1 (New Chicago area SF conference) at Doubletree Chicago O'Hare Airport Hotel, Rosemont IL. Guest of Honor: Randall Ingermanson. Registration: $25 until 31 January 2005, $35 at door. Info: www.consecration-con.org; chair@consecration-con.org; ConSecration I, Box 8193, Bartlett IL 60103-8193.

11–13 March 2005
STELLARCON 29 (North Carolina SF conference) at Downtown Marriott, Greensboro NC. Guests of Honor: Janny Wurts, Don Maitz. Registration: $30 until 1 February 2005, $35 thereafter. Info: www.stellarcon.org; stellarcon@yahoo.com; Stellarcon 29, Box 4, EUC, UNCG, Greensboro NC 27412.

24–27 March 2005
NORWESCON 28 (Northwest Regional SF conference) at DoubleTree SeaTac Hotel, SeaTac WA. Guest of Honor: Michael Bishop. Artist Guest of Honor: John Howe. Science Guest of Honor: Suzette Haden Elgin. Spotlight Publisher: Tor Books. Special Guest of Honor: Alan Dean Foster. Info: www.norwescon.org; info@norwescon.org; (206) 270-7850; Norwescon 28, Box 68547, Seattle WA 98168-0547.

25–28 March 2005
PARAGON2/EASTERCON 2005 (56th British National SF Convention) at Hanover International Hotel, Hinckley, Leicestershire, UK. Guests of Honor: Richard Morgan, John & Eve Harvey, Ben Jeapes, Ken MacLeod, Robert Rankin. Registration until November 2004: £40 attending, £15 supporting, £20 junior, £5 child. Info: www.paragon2.org.uk; sofa@paragon2.org.uk; +44(0) 114.281.0674; John Dowd, 4 Burnside Ave., Sheffield S8 9FR, UK.

4–8 August 2005
INTERACTION (63rd World Science Fiction Convention) at Scottish Exhibition and Conference Centre, Moat House & City Inn Hotels, Glasgow, Scotland. Guests of Honor: Robert Sheckley, Jane Yolen, Greg Pickersgill, Lars-Olov Strandberg. Registration until 30 November 2004: Attending USD170 /GBP95/EUR145; Supporting USD45/ GBP30/EUR45; Child's USD50/GBP32/ EUR50. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Info: Interaction, 379 Myrtle Road, Sheffield, South Yorkshire S2 3HQ, U.K. or Interaction, P.O. Box 58009, Louisville, KY 40268-0009; info@interaction.worldcon.org.uk; www.interaction.worldcon.org.uk.■

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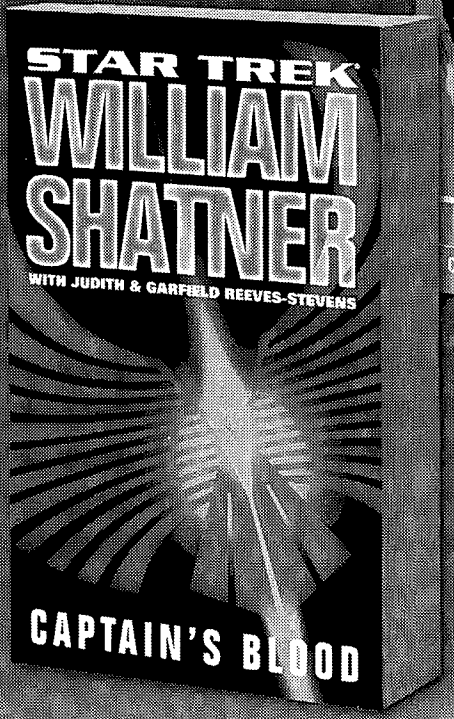

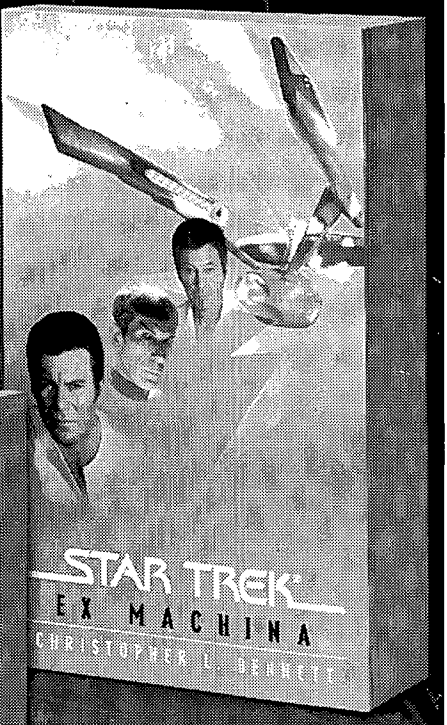

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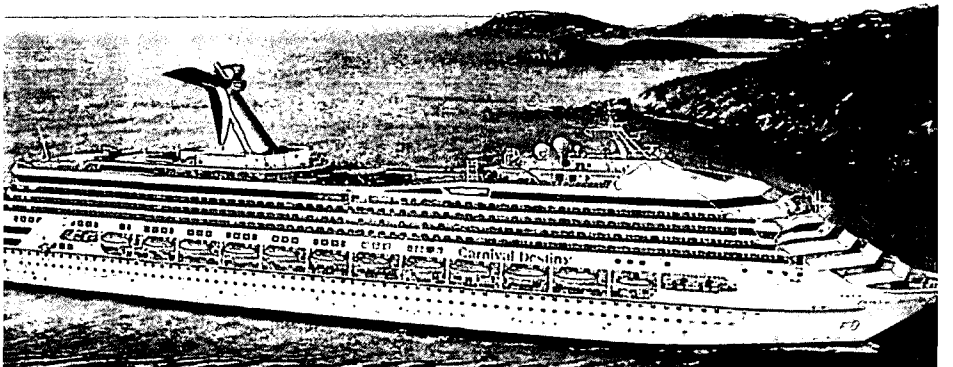

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